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461017

JULY, 1964

# QUARTERLY TECHNICAL PROGRESS REPORT No.10

# XV-5A

LIFT-FAN FLIGHT RESEARCH AIRCRAFT PROGRAM

CONTRACT NUMBER DA44-177-TG-715

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GENERAL  ELECTRIC

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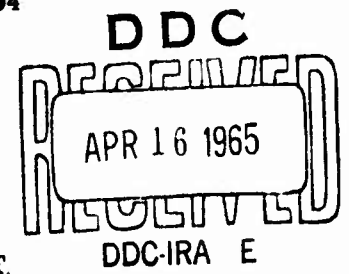
XV-5A LIFT FAN  
FLIGHT RESEARCH AIRCRAFT.

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Contract ~~DA~~ DA44-177-TC-715

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QUARTERLY TECHNICAL PROGRESS REPORT, NO. 10, 17 Feb - 15 May 64.  
~~For Period February 17, 1964 to May 15, 1964~~



~~ADVANCED ENGINE AND TECHNOLOGY CENTER~~

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GENERAL ELECTRIC COMPANY  
Cincinnati, Ohio.

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## ABSTRACT

### SECTION A - PROPULSION

During the tenth quarter propulsion system deliveries were completed with acceptance of the last spare lift fan. Fan speed VTOL and CTOL flight clearance was requested and granted for A/C number two. Lift fan and J85 spare parts were shipped to Edwards Air Force Base. Number one A/C completed modification and ground tests at NASA-Ames prior to full scale wind tunnel tests. Engineering design and analysis was completed for the higher loading in the exit louver actuation system.

### SECTION B - AIRPLANE

Both aircraft completed systems functional tests at San Diego. A/C number two was shipped to Edwards AFB to begin flight tests and A/C number one was shipped to NASA-Ames for wind tunnel testing. Nose wheel shimmy encountered during taxi tests causing aircraft damage. Nose gear redesign and successful dynamic and static tests were completed. A systems failure evaluation was conducted on the flight simulator to establish emergency procedures. A/C damage as a result of nose gear failure was corrected.

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## I. SUMMARY

During the tenth quarter (February 17, 1964 to May 15, 1964) progress under the propulsion system program included:

- Technical data for low speed flight clearance was completed, and low speed VTOL and CTOL flight clearance was granted for aircraft number two.
- Engineering design and analysis was completed for the higher loads necessary in the lift fan exit louver actuation system.
- The last spare lift fan was inspected and accepted by TRECOM technical personnel.
- J85 engine and lift fan spare parts delivered to Edwards AFB.
- Number one aircraft arrived at NASA-Ames, was modified and completed thrust stand tests prior to installation into the wind tunnel.
- Revised Propulsion System Maintenance Manual was issued.
- Propulsion system maintenance support was supplied during aircraft ground tests at Ryan San Diego, NASA-Ames, and Edwards AFB.

## II. DESIGN AND ENGINEERING

### A. SPECIFICATIONS AND REPORTS

Seven additional program technical reports were completed and transmitted to TRECOM during the reporting period. The subjects included such areas as wind tunnel model test results, structural design loads, fuselage structural analyses, aircraft structural test results, estimated static stability and control characteristics, landing gear drop test results, plus a summary of the installed systems functional test. These last reports completed the substantiation data necessary to request low speed flight clearance for Number Two XV-5A aircraft.

### B. EXIT LOUVER ACTUATION

During planned VTOL taxi tests and lift-offs on March 31, 1964, with aircraft Number Two at the General Electric flight test facility, Edwards, California, momentary lift-offs were achieved, however roll control was inadequate. The pilot's initial observations indicated that roll response was less than expected for the lateral stick motions he employed to recover the lowered wing tip. Subsequent analysis of the data recorded during this initial testing, plus additional pilot de-briefing, substantiated the apparent weak roll control.

A further series of ground tests revealed that fan exit louver stagger angle diminished as fan power increased. This is to say that at 40 degrees stagger setting, the exit louvers were forced open to approximately 30 degrees as fan speed increased from 70 to 95%. Coincident with opening of the louvers, it was noticed that actuation rod motion took place. The rod was forced back. Load links were manufactured and installed in place of the actuators.

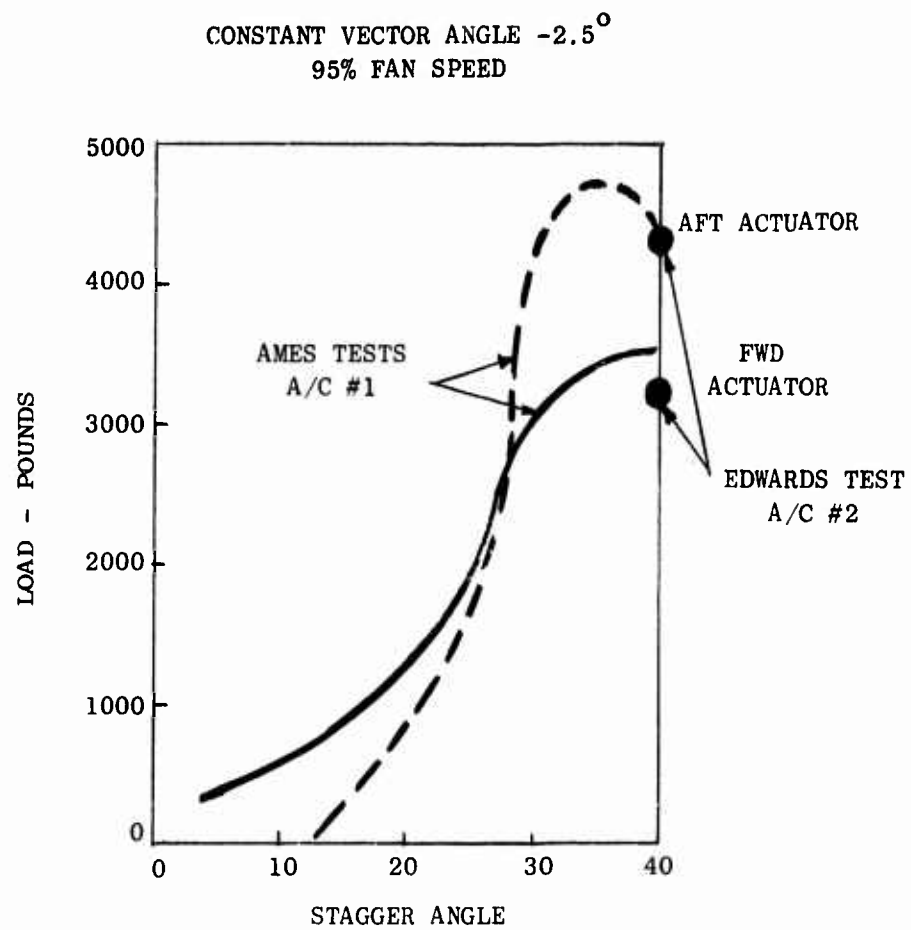


Figure 1 Measured Actuator Loads

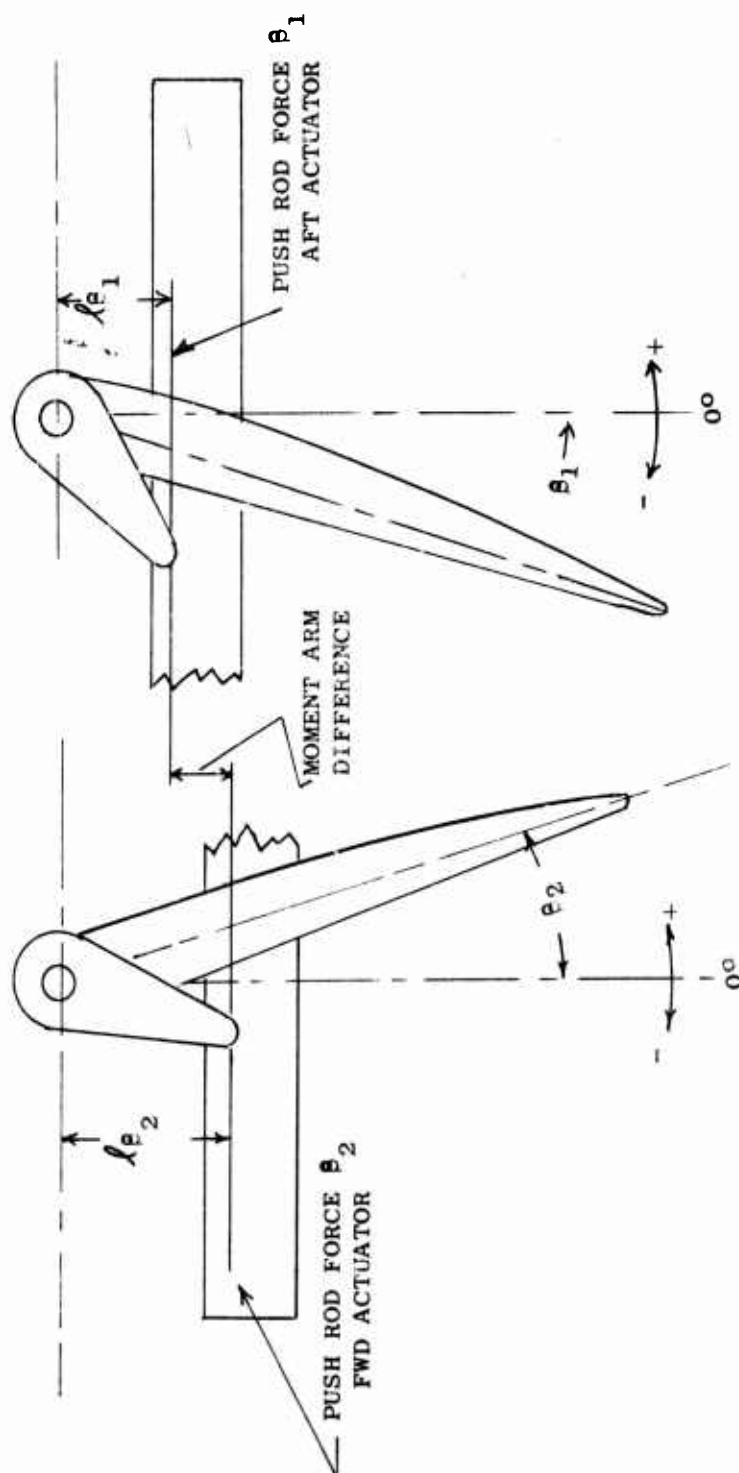


Figure 2 Exit Louver Geometry

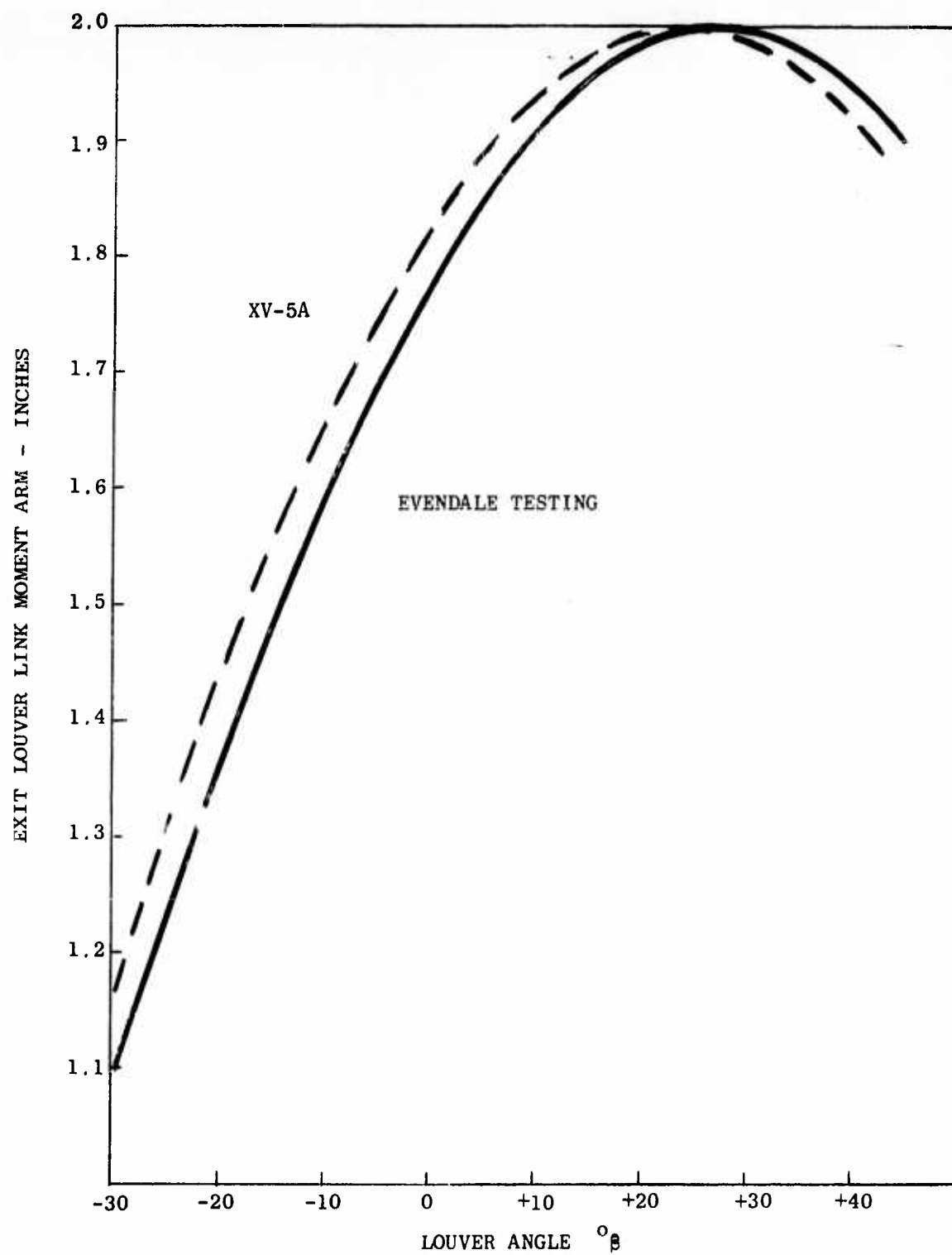


Figure 3 Louver Link Moment Arm vs Louver Angle

- B. An aerodynamic analysis was completed to determine why the measured push rod loads were greater than previously recorded during early fan-in-wing model wind tunnel tests. The results of this analysis are depicted in Figure 4 which gives the air loading as a moment around the louver leading edge. Two cases are shown in Figure 4: pure vector angles and also zero vector with the louvers staggered. The moment is proportional to the fan pressure rise ( $qj$ ) which is 1.33 psi at 100% fan speed, and varies with speed squared and inlet density. As can be seen in this figure, the loading moment is substantially greater under stagger conditions than during vector positions. The push rod loads measured during the earlier fan testing were for exit louver vectoring only.

The criteria used during the design of the new actuation hardware was to provide full aircraft roll control under J85 military power at standard day sea level conditions on a single hydraulic system. The required loads were based upon the measured results at both NASA/Ames and Edwards, plus the aerodynamic analysis in Figure 4.

a. Actuator

New hydraulic actuators are being manufactured to provide the increased force necessary. These actuators will be tandem piston type capable of 9600 lbs when both hydraulic systems are supplied with 3000 psi pressure. The aft actuators will have a slightly longer stroke to account for the longer moment arm on the aft push rod link. Modifications will be made to the servo-valve which supplies hydraulic pressure to the actuator so that the fluid flow rates are consistent with the increased piston size.

b. Lift Fan Changes

Push rod modifications will be made to stiffen the beam section for accommodation of the increased loads. The aft end of the aft push rod on each fan will be relieved slightly to provide clearance for the new actuation clevis.

M = MOMENT  
b = SPAN  
c = CHORD

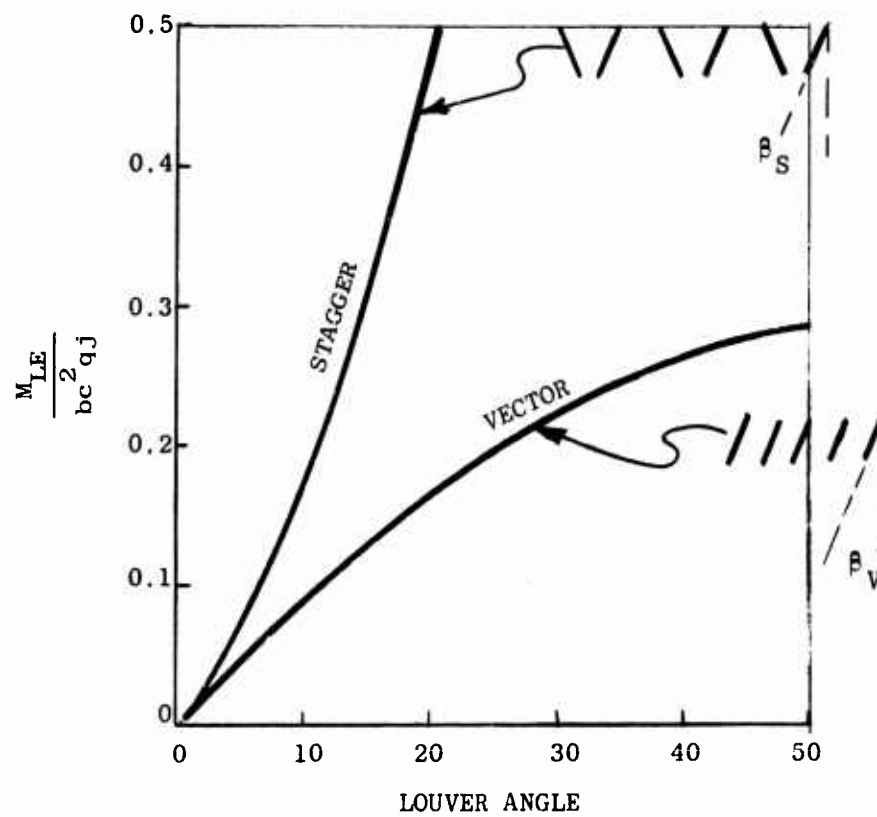


Figure 4 XV-5A Exit Louver Moments

- B. b. Push rod links will be changed to accept the increased loading as well as the new actuator clevis. In order to utilize equal size actuator pistons in the fore and aft locations, the moment arm of the aft link was increased from 2.0 to 2.55 inches (aft push rod loads are higher, Figure 1).

Modifications will be made to both ends of the rear frame strut to accept the increased loads. The existing lugs will be removed and the new design added.

c. Actuation Bracket

The increased size of the hydraulic actuators plus the need to minimize the bracket deflections under load, necessitates a completely new actuation bracket at both the front and rear locations.

A test plan was devised to demonstrate the flightworthiness rating of this new design. The selected test was felt to be the most severe loading the system will see during the 50-hour flight test program, however no attempt will be made to simulate the air loading to the louvers. Steady state maximum loading, impact loads, push rod to actuation cam scrubbing, and cyclic loading will be accomplished on a spare lift fan modified with the changes described above.

All modification hardware design has been completed with the first set scheduled for delivery in early June. Spare lift fan, S/N 003, has been prepared for shipment to Ryan, San Diego for modification and test.



C. AIRPLANE SUPPORT

EJECTION SEATS

Modification to the three LW-2 seats on hand at Edwards was made. Modification consisted of shortening the harness manual release handle and replacing an Adel pin in the parachute lanyard disconnect with a bolt and nut.

Two seats were armed, one for installation and use in Aircraft #2 at Edwards and the other for stand-by

A North American, Columbus, escape systems engineer inspected the seats after modification and arming. In addition, a briefing and training session for the XV-5A maintenance personnel and for Edwards AFB Crew and Systems personnel was held by the NAA representative.

The LW-2 seat oxygen system was used during initial aircraft flight testing. However, the limited oxygen available at 100% O<sub>2</sub> flow indicated desirability for a larger source. This larger source of O<sub>2</sub> has been installed in aircraft #2 and is now being used in lieu of the seat system.

### III. MANUFACTURE AND FLIGHTWORTHINESS TEST

#### A. PROPULSION SYSTEM HARDWARE

Spare lift fan, S/N 003L, was prepared for shipment, inspected and approved by TRECOM technical representatives, and sent to Ryan, San Diego for use as a test vehicle to verify the design integrity of the new exit louver actuation system. Delivery of this last fan completes the propulsion system manufacturing.

#### B. SPARE PARTS

One spare lift fan, one pitch fan, spare fan components, spare J85 components, and two J85 engines were shipped to the General Electric flight test facility at Edwards AFB, received, stored, and an initial inventory taken. Pitch fan spare parts are being packaged in preparation for shipment to Edwards.

A few remaining items still must be received to complete the fan spares requirements. These items include fan blades, bucket carriers, and exit louvers.

#### IV. AIRCRAFT GROUND TEST SUPPORT

##### A. INSTALLED SYSTEMS TESTING

Propulsion system functional tests were completed on both aircraft during the reporting period. These functional checks included cooling system checks, simulated flight transition with varying vector angles, fan overspeed cutback tests, conversions at 100% J85 rpm, aborted conversions, and thrust spoiler tests.

J85 running included power settings from idle to 100% rpm in both the straight-through and fan power modes. Conversions were accomplished with one J85 at 100% power setting and the other engine at 70% power to minimize the transient loading in the aircraft tie-down fittings. An acoustical survey was conducted for both flight modes. No propulsion system malfunctions occurred during these functional tests.

##### B. GROUND RESONANCE TEST RESULTS

During the ground resonance tests one A/C #2 at Ryan, San Diego, propulsion system support was provided to:

- 1) Monitor the induced loading on the lift and pitch fans, and
- 2) Accumulate data related to possible induced vibration from aircraft natural frequencies and resultant effects on the fans.

Of primary interest was the data pertinent to the fan vibration and loading during XV-5A cruise mode flight.

An initial acceleration limit of 0.5g max. or blocked rotor was established for the fans based on the possible effects (Brinnelling of thrust bearings) of loadings greater than 1g for the time periods required to define aircraft nodal patterns. This limit was felt to

- B. be inconsistent with the probable load input required to establish nodal surveys on the aircraft, and the blocked rotor concept raised questions as to the effect on the fan mass and spring constant in the total system. A test plan was established that provided fan protection, maximum freedom of test to establish aircraft nodal patterns, and provide data on the effects of fan rotor tie down.

Resonance testing was initiated with three crystal pickup accelerometers mounted on each fan. The pickups were located at the root and tip of one blade and on the root of another blade  $90^{\circ}$  from the first location. These locations were selected to measure g loading at the hub, possible bending in the blades, and in two planes to measure symmetry of the fan loads.

Rotor tie-down consisted of a bungee cord laced between the rotor blades and rear frame stator vanes. This tie down method was employed since the initial testing revealed the 1g unblocked rotor limit was reached before obtaining sufficient power to obtain nodal patterns as well as to have the least mass effects on the system.

The significant results obtained during the aircraft resonance testing was that during sweep to 100 cps, fan accelerometers were in phase with aircraft vibrations and no fan system vibrations were induced by aircraft resonance.

C. FULL SCALE WIND TUNNEL TEST PROGRAM

XV-5A aircraft number 1 arrived at the NASA-Ames Research Center on March 29, 1964 for conduct of the full-scale wind tunnel test. During this reporting period the aircraft was prepared for the forthcoming wind tunnel test program. As a result of the lateral roll problem encountered during the initial hovering attempt at Edwards AFB, a ground run was added to the test program to further investigate the

C. roll control problem. The following discussion presents the progress from the time the aircraft was received until the completion of the ground run program.

1. Aircraft Modification for Test

Prior to the actual test program, the aircraft was first modified into a test configuration capable of allowing complete remote operation of the system. This involved:

- a) Removal of the conventional pilot operated controls and replacement with a system of electric screw jacks and push rods. This system, when connected to the remote console provided operator control of the rudder pedals, conventional stick, collective stick, and engine throttles.
- b) Removal of all the cockpit aircraft instruments and installation of the necessary instruments in the remote engine operators console. This console was wired directly into the aircraft electrical system.
- c) Provision of fuel lines, through the wing, which attached to the aircraft plumbing and permitted the aircraft fuel tanks to be drained during the testing.
- d) Adding auxiliary CO<sup>2</sup> fire extinguishing system internally to the aircraft.
- e) Installation of instrumentation for the data recording necessary for the tests.
- f) Adding insulation to the aircraft at various locations to prevent overheating problems that may result due to the sustained engine and fan operation planned.
- g) Functional checks were made to insure satisfactory operation of all systems and instrumentation.



Figure 5 XV-5A on Outdoor Thrust Fan



Figure 6 XV-5A on Outdoor Thrust Fan

C. 2. Ground Run Program

The aircraft was moved to the NASA outdoor thrust stand on April 24, 1964 after completion of the modifications listed above. This new facility consisted of three scissor jack arrangements that pick up the aircraft's three mounting points (Figures 5 and 6). Load cells are connected to each of the three jacks and recorded during the tests. Aircraft ground height and pitch angle variations are possible on the stand.

The purpose of the ground run program was threefold:

- a) Investigate the roll control problem experienced on A/C number 2 at Edwards.
- b) Obtain force data for redesign of the exit louver actuation system.
- c) Demonstrate the endurance capability under sustained engine operation without aircraft overheat problems.

Preliminary evaluation of the results indicate the following:

- The aircraft cooling system is adequate to keep the aircraft structure within safe temperature limits during 20 minutes of sustained fan mode operation.
- The exit louver actuation loads were determined as indicated by Figure 1.
- Increased roll power was made available by increasing the exit louver actuator hydraulic pressure by means of an external supply. Considerable random data in the measured roll moments was seen, particularly at the neutral stick position. The exact cause of this data scatter was not determined during this test phase and additional ground tests are planned at the conclusion of the wind tunnel tests.

C. 2. At the end of this reporting period, the ground tests were terminated and the aircraft installation into the 40 X 80 foot tunnel was begun.

3. Plans for Next Quarter

Plans for the next quarter include completion of the full-scale wind tunnel test program and the additional ground run scheduled for investigation of the randomness of roll power.



## V. FLIGHT TEST SUPPORT

### A. INSTRUMENTATION

The PCM data acquisition unit and the airborne telemetry system were both installed and working in A/C number 2 at the close of the reporting period. The length of time required to re-wind and re-load the PCM tape transport indicated the desirability of obtaining another transport. Action has been initiated to acquire a new tape transport.

Additional propulsion system instrumentation was installed in the aircraft during this period, and included J85 vibration, fan frame temperatures, and fan cavity temperatures.

### B. MAINTENANCE MANUAL

The updated Propulsion System Maintenance Manual, Specification 124, was completed and distributed during the past reporting period.

### C. LOW SPEED FLIGHT CLEARANCE

As a result of the technical data submitted, plus a discussion held with TRECOM technical representatives, flight clearance for the XV-5A aircraft, serial number 62-24506, was granted for the following tests:

- 1) Hover.
- 2) Translational flight at velocities less than 30 knots KEAS during the VTOL mode.
- 3) High speed taxi tests.
- 4) Forward flight at velocities less than 280 KEAS during the CTOL mode.

C. Approval of the Detailed Flight Test Plan, Specification 129, was also received during this reporting period.

D. PROPULSION SYSTEM MAINTENANCE AND RUNNING TIMES

Propulsion system maintenance support was provided during the completion of aircraft ground tests at Ryan, San Diego, preparation of the aircraft and ground tests of NASA-Ames, as well as flight test support at Edwards AFB. This support included such efforts as (1) removal and reinstallation of a J85 engine from A/C number 2 for inspection of foreign object damage, (2) removal, repair, and reinstallation of the pitch fan as a result of the aircraft damage due to the nose gear failure, (3) repair of the lift fan exit louvers damaged by the nose gear failure and, (4) removal, repair of the gearbox leak, and reinstallation of a J85 engine from A/C number 1 at NASA-Ames.

J85 engine and fan running times are listed in Tables I and II.

E. FLIGHT TEST SUPPORT

A system for use of the required Air Force Base facilities was coordinated and is presently in effect. Base support includes: Fire and Crash Truck stand-by, special service ships, weight and balance facilities, etc.

Methods were established for rapid release of information to all interested parties on pertinent data on XV-5A flight tests and news releases.

Considerable data analysis has been accomplished from the ground tests at Edwards and NASA-Ames relative to the lateral control problem. Additional analysis support was also provided to fully

TABLE I J85 RUNNING RECORD

Engine S/N	Location	Prior (Hrs.)	Since P.I. (Hrs.)	Ryan (Hrs.)	Edwards (Hrs.)	Status
230-729	Edwards	79:16*	14:07	8:23	5:44	Installed in #2 aircraft.
-730	Edwards	80:40*	15:17	9:29	5:48	Installed in #2 aircraft.
-875	NASA-Ames	--	10:18	10:18	--	Installed in #1 aircraft.
-876	NASA-Ames	--	9:15	9:15	--	Installed in #1 aircraft.
231-230	Edwards	0	0	0	--	-5A configuration - new
-231	Edwards	0	0	0	--	-5A configuration - new
-232	Edwards	0	0	0	--	-5A configuration - new
-233	NASA-Ames	0	0	0	--	-5A configuration - new

\* Includes running time from flightworthiness test

TABLE II FAN RUNNING TIME

<u>Lift Fans</u>					
<u>Fan S/N</u>	<u>Location</u>	<u>P/C</u>	<u>Ryan Hrs.</u>	<u>Edwards Hrs.</u>	<u>NASA Hrs.</u>
003L	Evendale	spare	-	-	-
004R	Edwards	#2	3:25	1:51	-
005L	NASA-Ames	#1	1:06	-	3:20
006R	NASA Ames	#1	1:06	-	3:20
007L	Edwards	#2	3:25	1:51	-
008R	Edwards	spare	-	-	-

<u>Pitch Fans</u>					
001	Edwards	spare	-	-	-
002	NASA-Ames	#1	1:06	-	3:20
003	Edwards	#2	3:25	1:51	-

E. understand the nose wheel shimmy and failure. Redesigns to correct both of these problem areas was accomplished utilizing the Edwards data reduction and analysis support.

VI. MILESTONES

<u>Number</u>	<u>Milestone</u>	<u>Planned Date</u>	<u>Actual Date</u>	<u>Anticipated Date</u>
15A	Government acceptance of lift fan (L003)	Dec. 15	April 21	
26	Instrument and prepare for shipment lift fan (L003)	Dec. 30	May 25	

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## I. SUMMARY

This is a combined progress report covering the work done by Ryan Aeronautical Company during the ninth and tenth quarters of the program originated by Contract Number DA 44-177-TC-715.

During the ninth and tenth quarters (15 November 1963 to 15 May 1964) progress included:

- Estimated Static Stability and Control Characteristics Report, Ryan Report No. 64B031 was completed.
- The 6 Degree-of-Freedom hovering and transition flight simulation was completed.
- The Conventional Flight Low Speed Wind Tunnel Report No. 63B128 was completed.
- The Final Performance Report No. 64B058 was completed.
- A systems (electrical, controls, hydraulic and propulsion) failure evaluation was conducted on the flight simulator to establish emergency procedures and to determine system reliability.
- Some control system and stability augmentation system refinements were made as a result of the flight simulation program.
- Seven Stress Reports, Ryan Reports No. 64B026, 64B044, 63B029, 63B130, 63B131, 64B012 and 63B124 were completed.
- The Structural Design Loads Report, No. 64B029 was completed.
- The Structural Design Criteria Report, No. 62B094 was updated and re-issued under Report No. 62B094A.
- The Final Calculated Weight Report, No. 63B123 was completed.
- Flutter analysis indicated that some elements of the horizontal and vertical stabilizers must be stiffened to increase the flutter speed.
- XV-5A Heating and Cooling Analysis Summary Report, No. 64B039 was issued.
- Structural and System Design Report was directed to correcting deficiencies determined by the ground test efforts at Ryan, and the flight test efforts at Edwards Air Force Base.

- Manufacturing fabricated new parts required to support the ground and flight test operations.
- Installed systems functional tests were completed on both aircraft, and the required design fixes were incorporated.
- Flight Instrumentation installation was completed on both aircraft.
- Aircraft S/N 4506 shipped to Edwards Air Force Base on 27 February 1964.
- Initial low speed taxi tests were conducted 21 March 1964 and 30 1964, indicating good ground handling characteristics.
- Initial hovering attempted on 31 March 1964, and discontinued because of apparent lack of roll control in the fan mode.
- Nose wheel shimmy encountered on first high speed taxi test on 8 April 1964.
- Nose landing gear collapsed during second high speed taxi run due to nose wheel shimmy.
- A redesigned nose landing gear assembly was tested at the Lockheed spin test facility on 7 May 1964 at speeds up to 125 knots with no indication of shimmy.
- The period from 15 April 1964 to 14 May 1964 was spent in repairing damage to the aircraft.

## II. DESIGN AND ENGINEERING

### A. STABILITY AND CONTROL

#### 1. Progress

The Estimated Static Stability and Control Characteristics Report, Ryan Report No. 64B031, was completed. Work on the Dynamic Stability Report was delayed due to the effort required for the final flight simulation. This report is approximately 99 percent complete at the close of this quarter.

The 6 degree-of-freedom hovering and transition flight simulation, utilizing the complete aircraft hydraulic, electrical, and mechanical control systems, was completed during this period. Analysis of flight simulation data was begun to determine stability and control characteristics in the lift-fan flight mode to form the basis for the final Predicted Flying Qualities Report. The Flying Qualities Specification was reviewed to determine an outline of the requirements which could be investigated by means of the Flight Simulator.

#### 2. Schedule

The Dynamic Stability Report and the Flying Qualities Report are behind schedule due to the extended schedule of the Flight Simulation Program.

#### 3. Plans for Next Quarter

- a. Completion of the Dynamics Stability and Predicted Flying Qualities Reports.
- b. Preparation of data for comparison with Full-Scale Wind Tunnel Test Results.
- c. Support of Flight Test Program.

B. AIRCRAFT PERFORMANCE

1. Progress

The Conventional Flight Low Speed Wind Tunnel Report was issued as Ryan Report No. 63B128. In addition, Final Performance Report, Ryan Report No. 64B058 has been completed.

2. Schedule

All scheduled performance work has been completed.

3. Plans for Next Quarter

Support of the Flight Test Program, as required, will be the area of effort of the Performance Group for this period.

### C. CONTROL SYSTEM ANALYSIS AND SIMULATION

#### 1. Progress

This period encompassed the hardware-connected fan-powered and low speed conventional flight simulation, as well as Stability Augmentation (SA) system tests, using the final SA system configuration during ground engine runs at the San Diego plant.

The ground engine run installed system tests were uneventful. All axes responded smoothly to aircraft movements with no indication of system noise or structural feedback.

The final hardware simulation covered a review of all previous simulation work and pilot evaluations, as well as some subjects not previously covered, such as the failure simulation program and the hovering SA system gain optimization program using gusty wind inputs.

A considerable number of small control system configuration changes were made. Some control system functions were added, and some problem areas were exposed which previously had not been discovered.

Of particular value was the failure simulation program, which provided pilot training under the conditions of the most-expected single component failures, as well as some dual failures involving the horizontal stabilizer conversion program.

These subjects will be detailed in the Final Systems Analysis and Simulation Report, which will be published during the next quarter.

#### 2. Schedule

All efforts are complete, except the Final Report which is behind schedule.

#### 3. Plans for Next Quarter

Completion of the final Systems Analysis and Simulation Report is planned for this period.

D. STRUCTURAL ANALYSIS

1. Progress

(a) Stress Analysis

During this reporting period, the Stress Analysis Group completed the following stress reports:

Static Test Results	Ryan Report 64B026
Main Landing Gear Drop Test	Ryan Report 64B044
Structural Analysis of Fuselage Shear and Bending	Ryan Report 63B029
Structural Analysis of Fuselage, Frames, Bulkhead, Fittings, and Miscellaneous Components	Ryan Report 63B130
Structural Analysis of Center Fuselage and Engine Mounts	Ryan Report 63B131
Stress Report Main Landing Gear Shock Strut	Ryan Report 64B012
Controls Stress Report	Ryan Report 63B134

The Structural Analysis Group continued liaison with factory and ground test efforts, including such items as providing tie-down requirements and investigating heating areas of the aircraft for strength degradation. Extensive effort was also conducted in analyzing the VTOL thrust stand support cradle and aircraft structure affected by tie-down loads.

(b) Loads Analysis

Except for aircraft design modifications requiring minor loads analyses, the present reporting period involved documentation of formal reports.

Structural Design Loads, Ryan Report No. 64B029, was issued. Its contents and results are indicated by the conclusion stated therein:

"All XV-5A structural loading conditions have been evaluated and shown commensurate with inherent structural integrity and to comply in scope, and with the requirements set forth by the Structural Design Criteria,... except for rolling pull-out conditions which produce, in combination, vertical and lateral load factors in excess of 2.5 and 0.8, respectively."

Structural Design Criteria, Ryan Report No. 62B094, has been updated and re-published as Ryan Report 62B094A, in order to reflect current aerodynamic characteristics and, in particular, actual strength capability as shown in the foregoing paragraph.

(c) Weight Control

The Final Calculated Weight Report, Ryan Report 63B123, was issued showing the aircraft weight empty at 7,541 pounds prior to ground run tests.

Fuel center of gravity travel at different aircraft attitudes was determined in order to provide more exact location of aircraft center of gravity at any given time of flight, (Figure 1).

Weight records continue to be updated to reflect engineering and instrumentation changes, as well as shop rework.

(d) Flutter and Vibration

(1) Progress and Analysis

Correlation of the results of the static and dynamic test of the horizontal stabilizer with analyses indicated low flutter speeds due to an inadequate pitch restraint. Re-examination of the analytical work was directed toward uncovering any error which might lead to an erroneous interpretation. This was accomplished with errors being uncovered of 2nd order magnitude. Examination of the experimental data and test set-up of the horizontal tail pitch restraint led to the conclusion that the test set-up was inadequate and a re-test was conducted. Investigations of redistribution of elevator mass-balance and stabilizer mass-balance also were covered during the reporting period to determine their effects on the horizontal stabilizer flutter speed. Results of these tests indicated that the empennage elements should be stiffened. The 3 days required for modification will be scheduled to suit the Flight Testing Schedule.

(2) Experimental

During the reporting period, the last phase of the Ground Vibration Test (Ryan Report 63B086) was completed. This phase placed emphasis on obtaining the vibration characteristics of the individual components of the aircraft such as control surfaces, flaps, fan doors, etc. Reduction of the data gathered during the above phase had been completed during the reporting period, and will be included in the forthcoming Ground Vibration Test Report.

2. Schedule

(a) Stress Analysis

All scheduled reports have been completed with the exception of the one showing stress analysis of the engine air inlet; the thrust spoiler, and the pitch fan louver installation.

(b) Loads Analysis

All loads analysis efforts are completed.

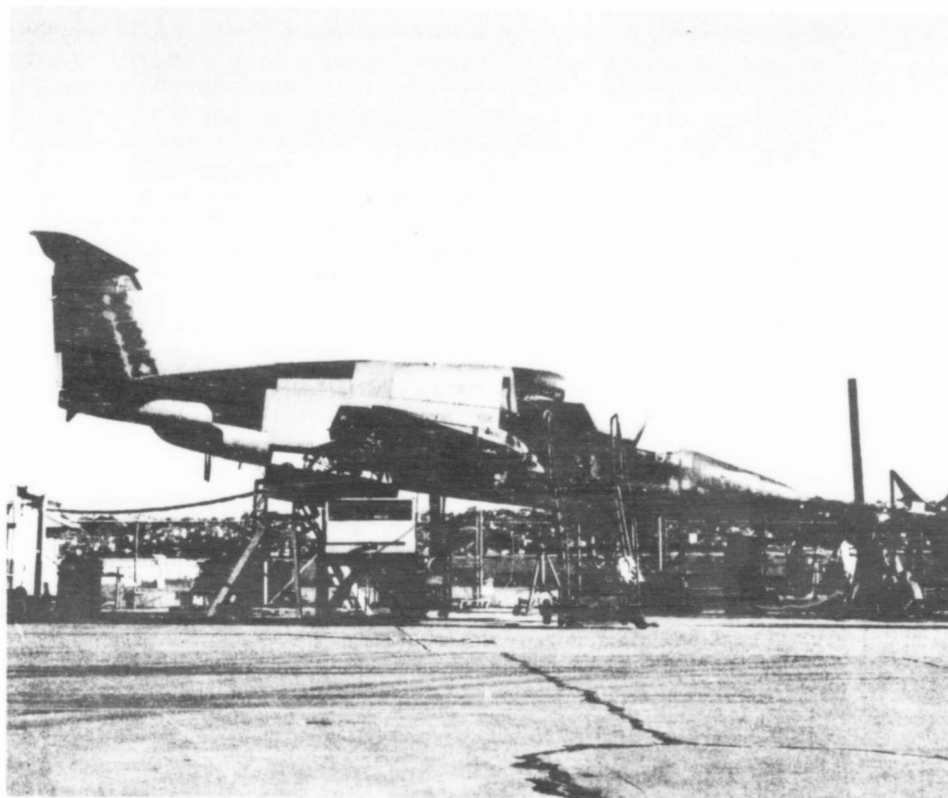


Figure 1 Determination of Aircraft cg



(c) Weight Control

The weight control program was on schedule at the end of this reporting period.

(d) Flutter and Vibration

Scheduled release of flutter, vibration and acoustic reports have experienced some slippage, due to unforeseen difficulties with the flutter margins of the horizontal stabilizer and crosschecking of analytical and experimental data.

3. Plans for Next Quarter

Plans for the next quarter include:

(a) Stress Analysis

The report showing stress analysis of the engine air inlet, the thrust spoiler, and the pitch fan louver installation will be completed in the next quarter. Continuing stress analysis efforts will be required in the support of ground and flight tests and the support of resulting design changes.

(b) Loads Analysis

Loads analyses as required to support aircraft changes will be accomplished in this period.

(c) Weight Control

The next quarter will primarily include maintenance of current weight and cg for the flight test articles.

(d) Flutter and Vibration

Release of preliminary flutter analysis, ground vibration, wind tunnel flutter model test and acoustic reports currently is scheduled for completion in the next six months.

## E. THERMODYNAMICS

### 1. Progress

Most of the effort expended during this period was in direct support of the Integrated Systems Functional Test Program of Aircraft No. 2 (S/N 24506). This effort included instrumentation liaison, establishment of allowable temperature limits, monitoring of all temperature data during test, data reduction and analysis, and resolution of various heating problems. Some specific studies completed in support of the test program are:

(a)

Landing gear insulation requirements were established based on the design requirements of Tables 1 and 2.

(b)

Estimated performance of the selected insulation, (5/8" Johns Manville Min K 1301) is presented in Figure 2. The selected configuration provides maximum performance, minimum weight and minimum envelope.

(c)

Effects of hot gas re-ingestion and horsepower extraction on EGT at various gas generator speeds were determined. Results are presented in Figures 3 and 4.

(d)

Thrust spoiler effectiveness was estimated, and is shown in Figure 5.

(e)

The estimated performance of ducting insulation shown in Table 3 was prepared in support of the decision to replace the Fiberglas laminate duct shrouds. Comparative performance indicates a potential increase of 3.5 percent in gas horsepower delivered to the pitch fan, and a substantial reduction in surface temperatures; however, some weight increase occurred.

(f)

Apparent discrepancies in some measured temperatures during test prompted an evaluation of possible thermocouple errors due to installation, particularly in the tailpipe shroud region. Analysis showed significant "installation errors", which when accounted for, brought predicted and test results into acceptable agreement.

(g)

Back flow experienced during high thrust spoiler angles led to an analysis of ejector trim-back. The resulting estimated effect on tailpipe ejector performance shown in Figure 6.

The effect of fuselage pressure on cooling air supply to the fuselage has been analyzed for various gas generator speeds, operating altitudes, and standard and hot days. Typical results are presented in Figure 7, 8 and 9. Combined with cooling air outflow from the fuselage through available exit flow areas (including leakage areas), the above figures permit establishment of actual cooling air flow rates for various conditions of operation. Total cooling air taken on board and the attendant cooling air drag have been calculated and will appear in subsequent reports. Evaluation of heating loads and resulting cooling system performance is about 75 percent complete. A typical estimated structural temperature distribution in the XV-5A engine compartment is shown in Figure 10.

Report No. 64B015, Calculated Installed Power Plant Performance, U.S. Army XV-5A Lift Fan Aircraft, is complete except for the inlet performance section. Decision has been made to review the David Taylor Model Basin high-speed wind-tunnel data before completing the inlet section and release of the report. Report No. 64B039, XV-5A Heating and Cooling Analysis Summary, dated 7 March 1964, was prepared and issued during this period.

## 2. Schedule

Documentation of the thermodynamics analysis is on schedule; however, final reports are behind schedule. All thermodynamics reports will be completed during the next quarter.

## 3. Plans for Next Quarter

Efforts will include review of David Taylor Model Basin Inlet Model wind-tunnel data; completion of inlet model wind-tunnel, installed power plant performance, heating and cooling reports and continued support of the XV-5A aircraft during NASA-Ames full scale wind-tunnel test and Edwards Air Force Base flight test programs.

TABLE 1 XV-5A AIRCRAFT OPERATIONAL DESIGN CRITERIA

Case	Operation or Test	Time Min.	Mode	J85 SP'D % RPM	H/D	V <sub>p</sub> Knots	$\beta_v^*$	Landing Thrust Gear Spoiler*	Fan Turbine Exhaust Temp. °F **
a	Ground Check	5	Fan	<86	1.0	0	45 to -5	Down ----	800
b	Ground Check	1.5 after 5 min. @ (a)	Fan	100	1.0	0	0	Down ----	1000
c	Flight Test	20* after 5 @ (a)	Fan Hover	100	>3	0	0	Down ----	1000
d	Flight Test	20* after 5 @ (a)	Fan Flight	100	>3	0-80	0 to 35	Down ----	1000
e	Flight Test	5 after 5 @ (d)	Fan Flight	100	>3	80-100	35 to 45	Down ----	1000
f	Flight Test	20	Fan Taxi	86	1.0	0-60	0 to 35	Down ----	800
g	Flight Test	0.5 after 5 @ (a)	Fan STOL	100	1.0	0-80	0-40	Down ----	1000
h	Flight Test	2	Fan Conver- sion	100	>3	120	Closed	Down 0-75	1000

\* or until minimum fuel reserve is reached, whichever is less.

\*\* based on NASA-Ames and recent Ryan XV-5A test data.

TABLE 2 XV-5A AIRCRAFT STRUCTURAL TEMPERATURE LIMITS

	<u>Design</u>	<u>Max. at 1 g Load</u>
Aluminum Alloys	250 F°	325°F
Titanium -99 T <sub>C</sub>	550 F°	1000°F
6AL4V	700 F°	1100°F
Magnesium AZ318H24	250 F°	400°F
Steel - Mar-age	300 F°	700°F
Fiberglas Laminate - Silicone	700 F°	700 F
Rubber - Silicone	450 F°	450°F

TABLE 3 ESTIMATED PERFORMANCE OF XV-5A PITCH FAN DUCTING INSULATION

		<u>H.I. Thompson Blanket*</u>	<u>Present Shroud</u>
Pitch Fan Bleed Gas Temperature	°F	1250	1250
Pitch Fan Duct Temperature	°F	1228	1190
Inside Insulation Temperature	°F	1228	863
Outside Insulation Temperature	°F	566	839
X-Duct Compartment Air Temperature	°F	250	250
X-Duct Compartment Wall Temperature	°F	250	250
Heat Loss Per Foot of Ducting Btu/hr ft.		2040	5490
Temperature Loss of Pitch Fan Bleed Gas	°F	8	21.6
% Loss Available Gas Horsepower to Pitch Fan	%	0.47	3.99

\* Blanket Construction: Inside surface (hot), 0.0015" stainless steel foil; insulation, 3 layers 3.0 lbs/ft<sup>3</sup> density nominal 0.19" thick H.I. Thompson A-100 Batt compressed to 0.5" thickness; outside surface (cold), 0.002" stainless steel foil; "wick proof" and ventilated.

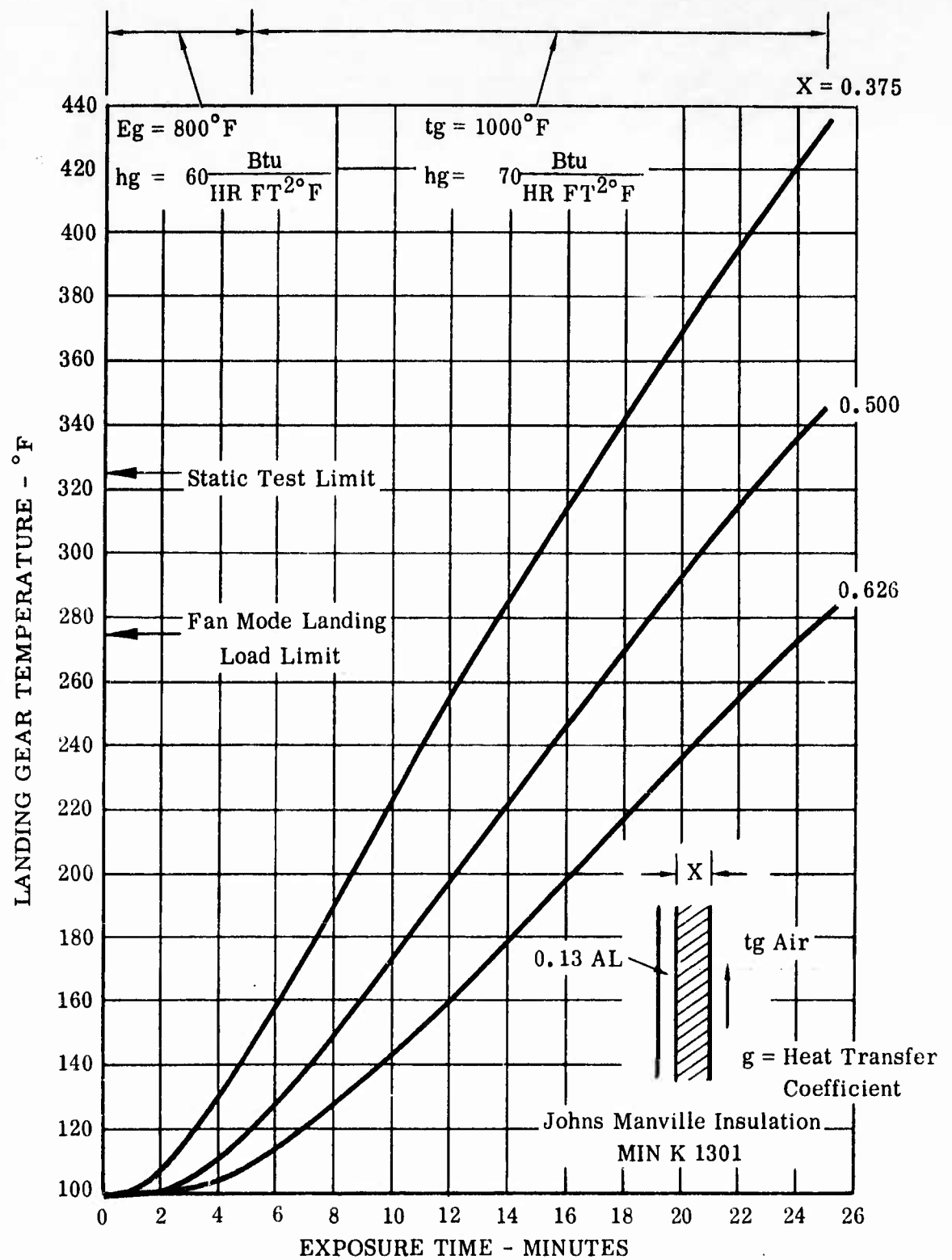


Figure 2 Estimated Performance of Insulation Min K 1301

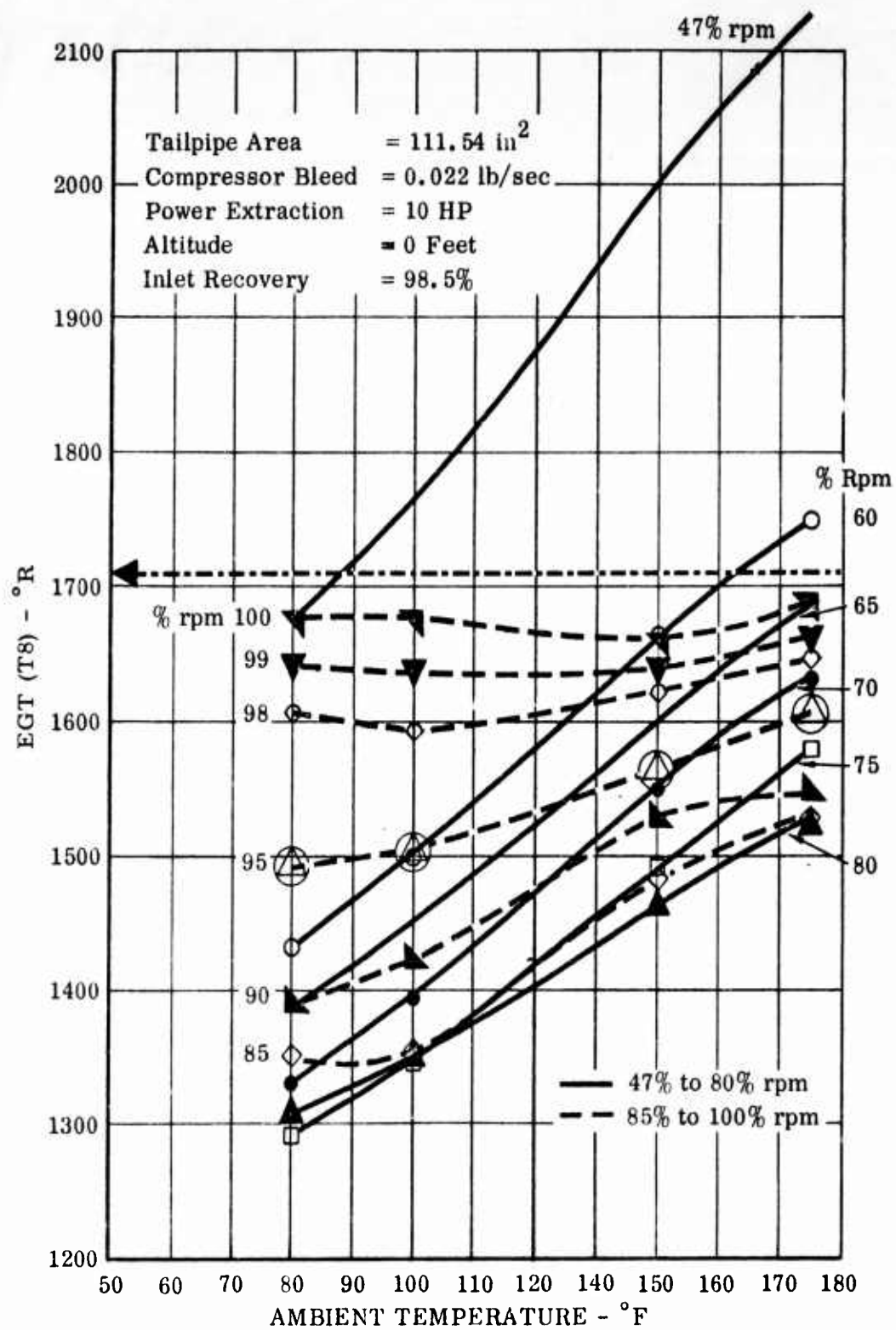


Figure 3 Effect of Re-Ingession and % rpm on Exhaust Gas Temperature

ARDC Std Day  
Altitude = 0 Feet  
Bleed Air = 0.022 lb/sec  
Inlet Recovery = 0.985

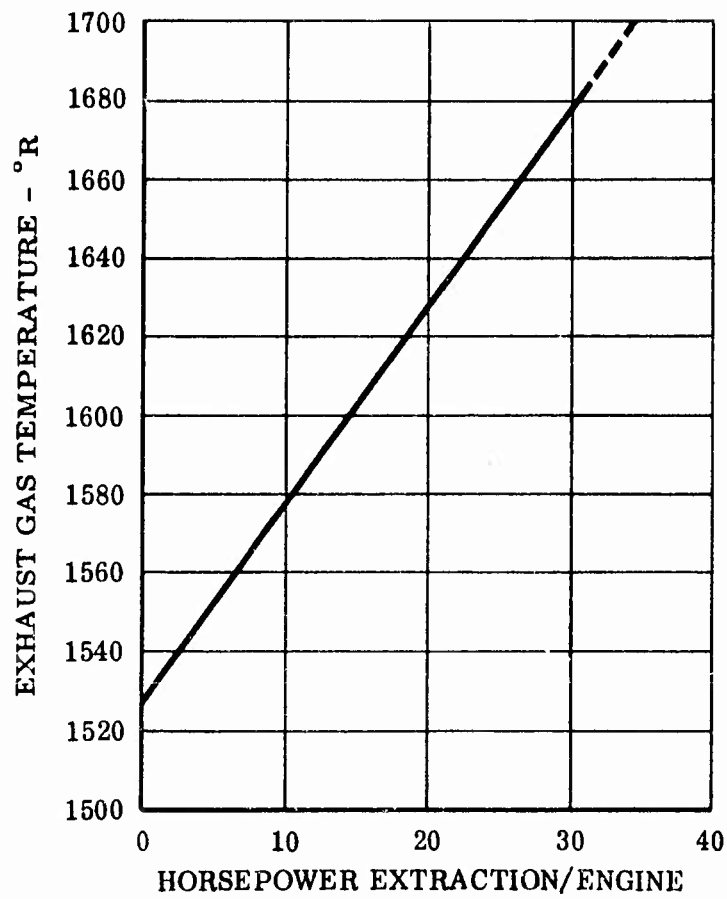


Figure 4 Horsepower Extraction versus Exhaust Gas Temperature



Operating Conditions

ANA Bulletin Hot Day

Altitude 2500 Feet

Engine rpm 100%

A Based on Effective Angle to Nozzle ( $\alpha - 10.8^\circ$ )

B Based on Relative Angle to Nozzle ( $\alpha - 7^\circ$ )

C Based on Cosine of Relative Angle ( $\alpha - 7^\circ$ )

Note:  $\alpha$  = Angle of Thrust Spoiler Deflection

100% Deflection =  $81^\circ$

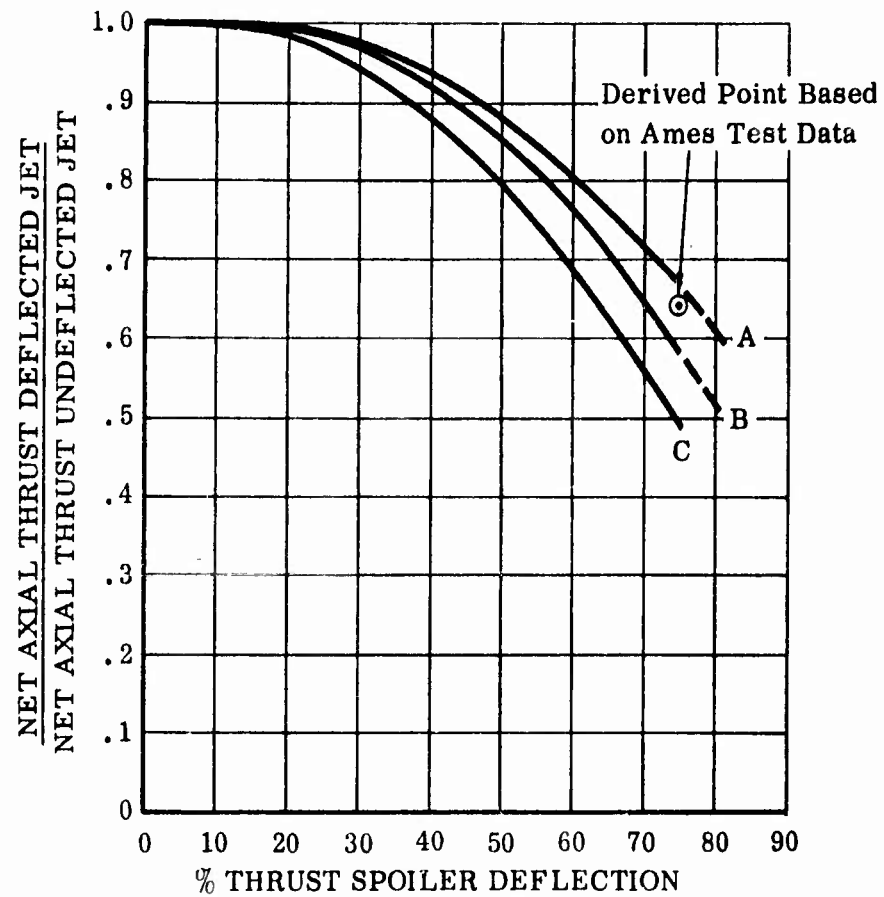


Figure 5 Thrust Spoiler Effectiveness

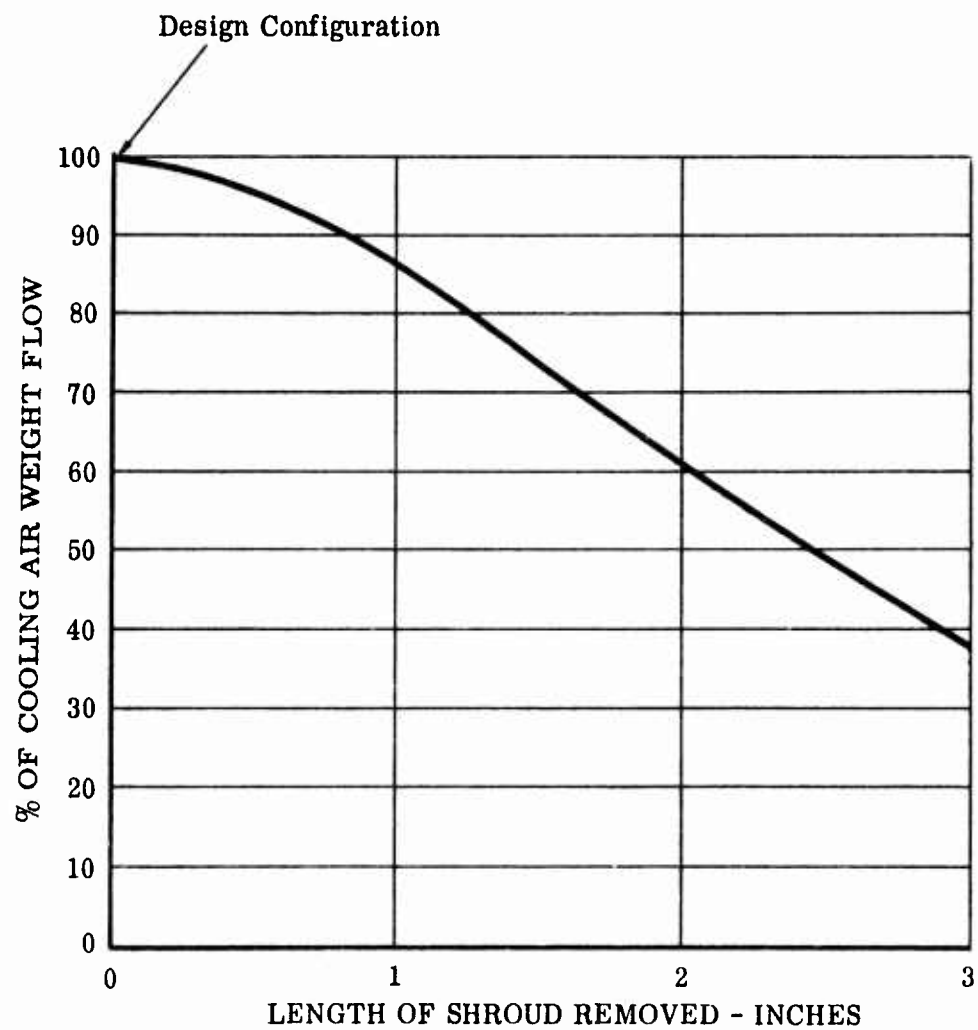


Figure 6 % of Cooling Air Weight Flow versus Length of Shroud

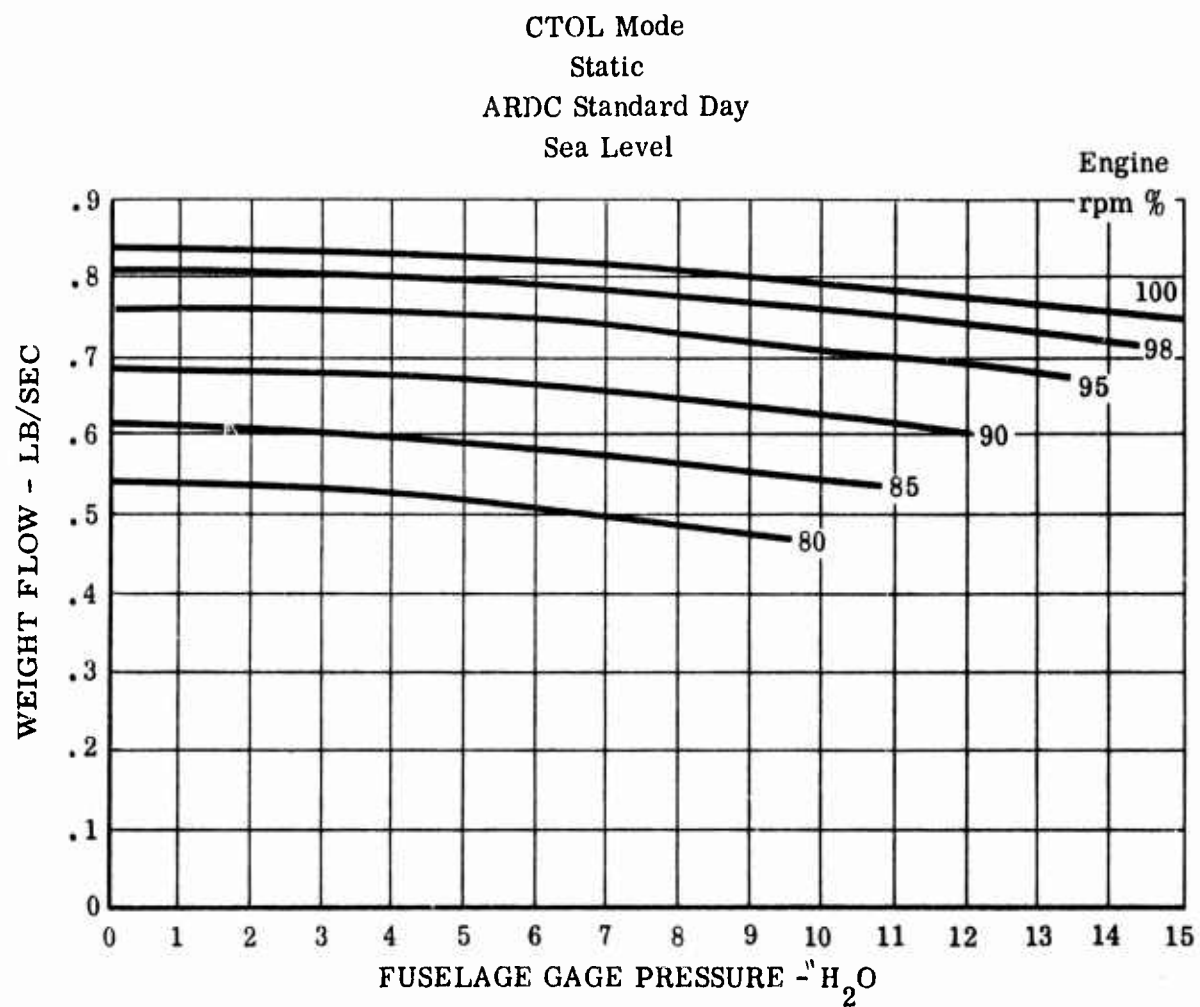


Figure 7 Cooling Air Weight Flow from Small Cooling Fans to the Generators  
versus Fuselage Pressure and % rpm

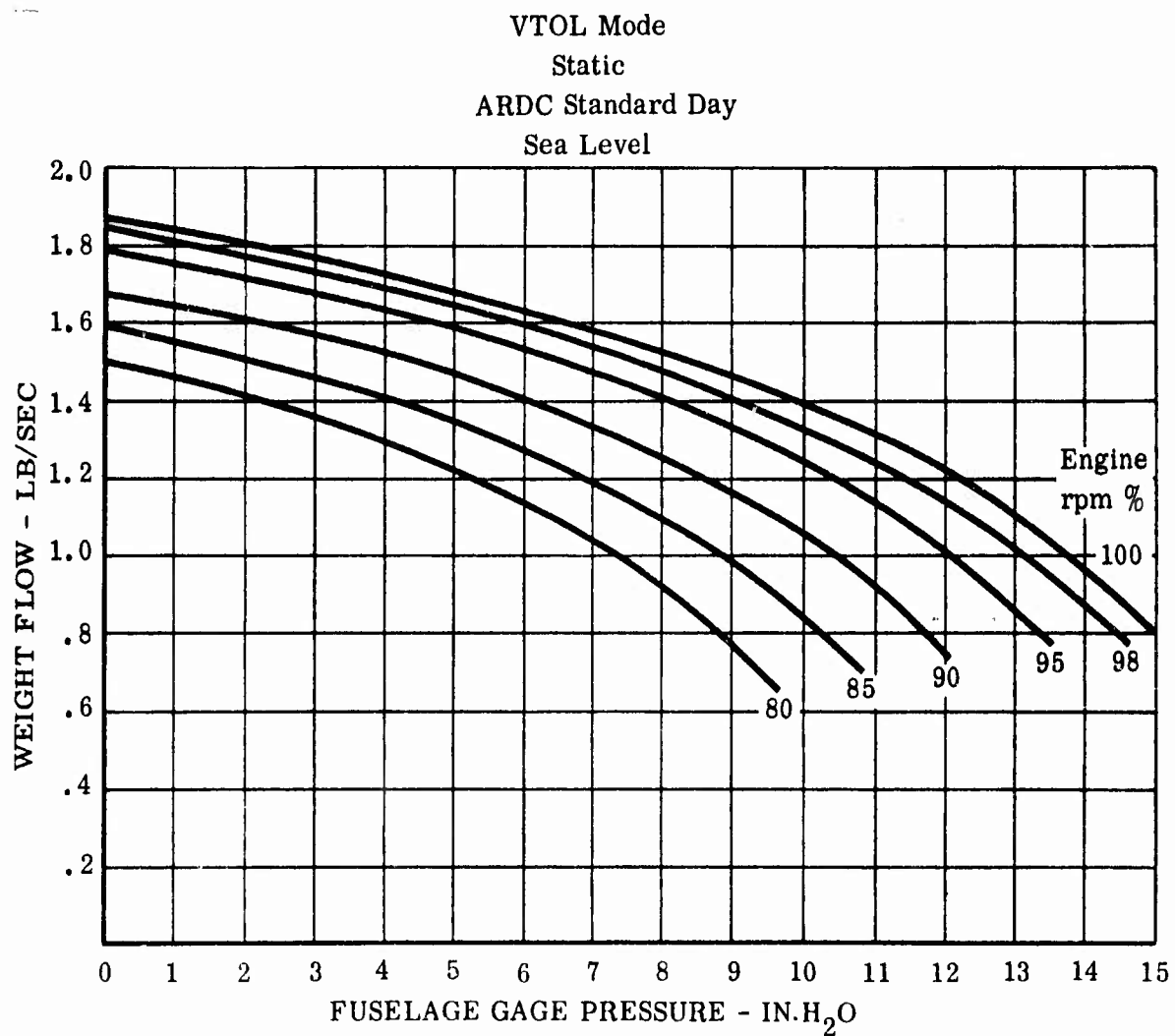


Figure 8 Cooling Air Weight Flow from Small Cooling Fans Through Hydraulic Oil Coolers to Electronic Bay versus Fuselage Pressure and % rpm

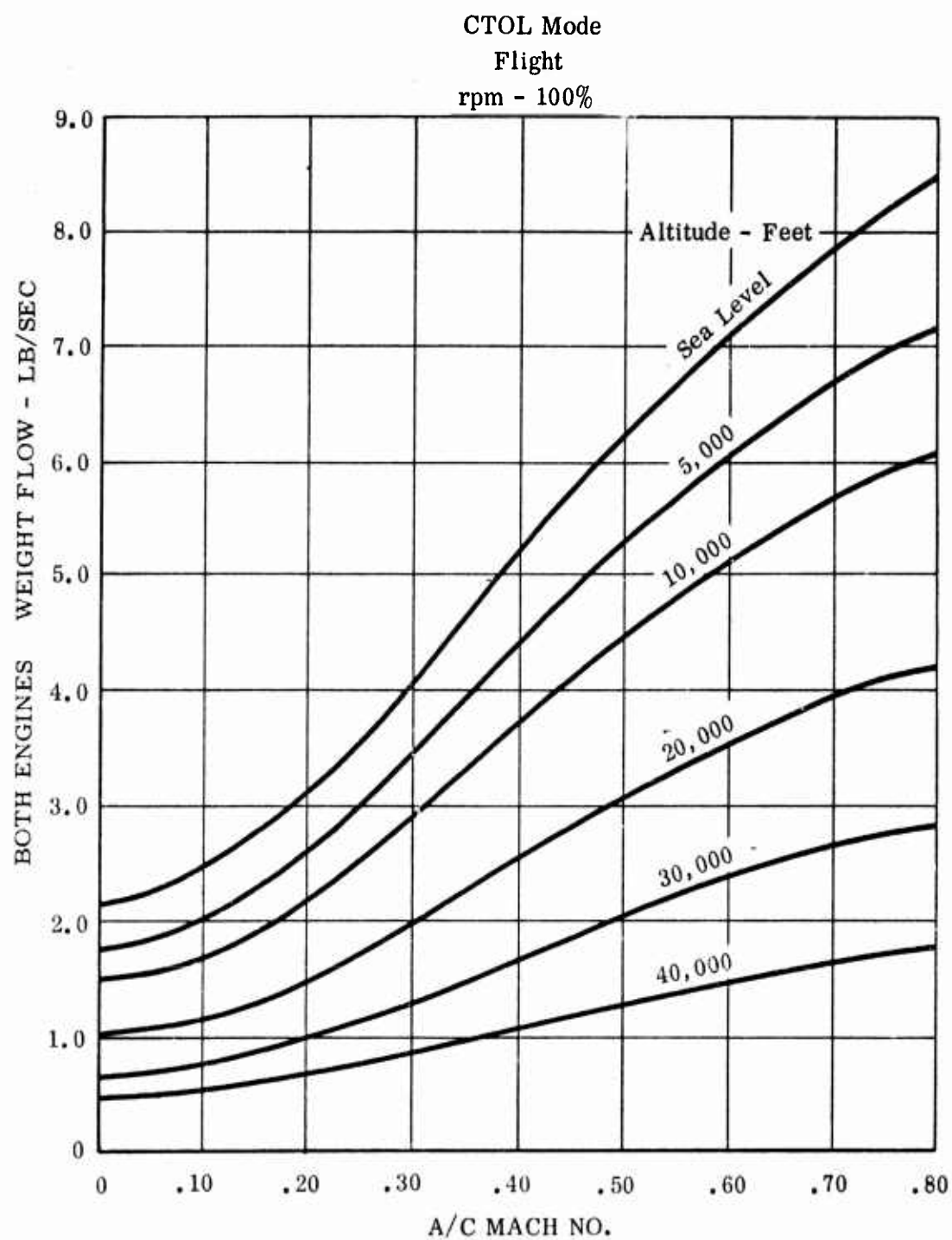


Figure 9 Cooling Air Weight Flow from Engine Bays to Tail Pipe Ejectors versus Mach No., Altitude and Standard Day

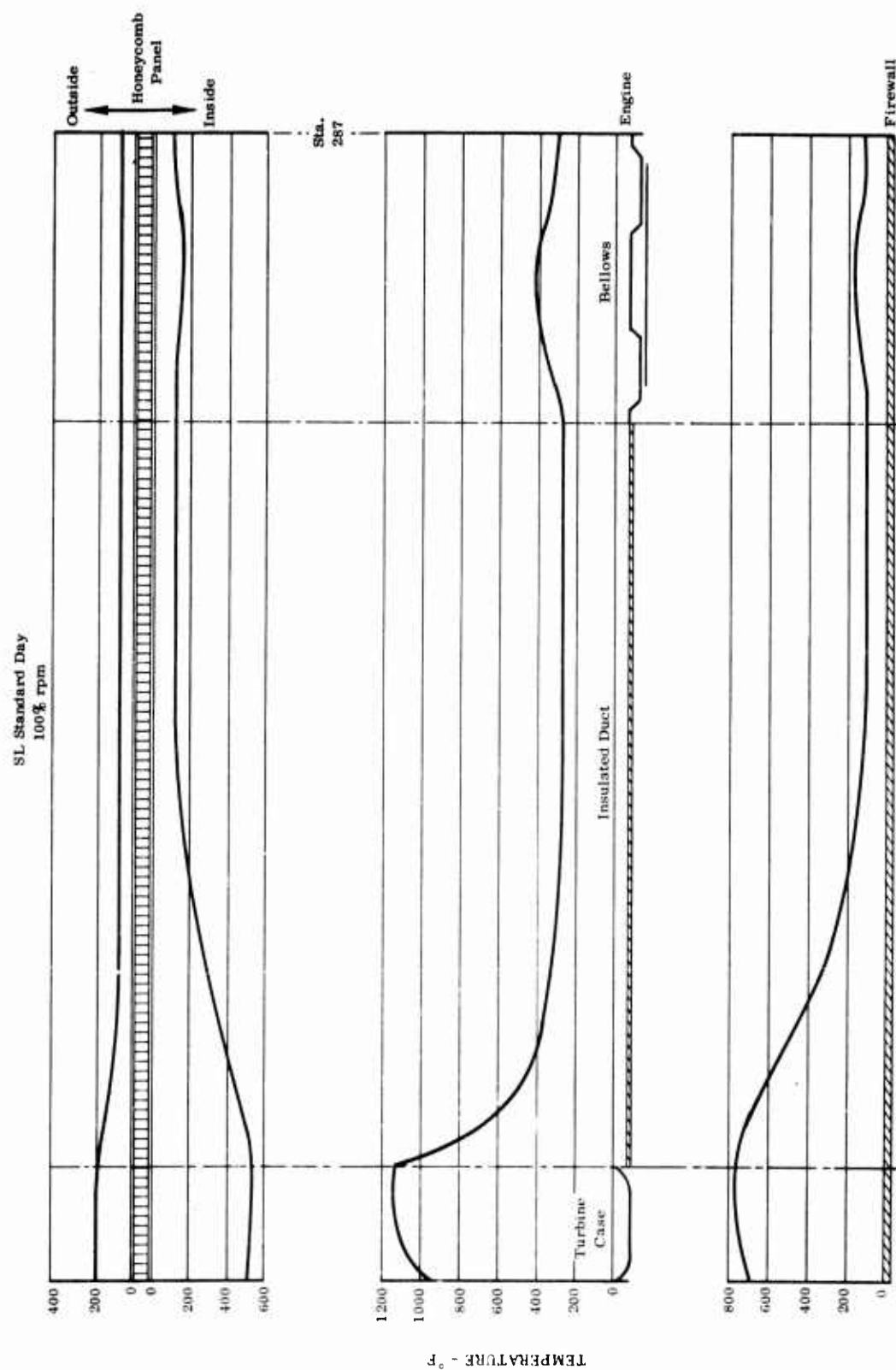


Figure 10 Temperature Analysis of Engine Bay

F. RELIABILITY

1. Progress

A coordinated Republic Pre-Flight Safety Survey was performed on Aircraft No. 2 with no major changes resulting. All items were corrected before start of ground tests. A typical effort was the investigation of systems test failure of Main Landing Gear during retraction tests. Diagnosis indicated two malfunctions occurred. These were:

(a)

The left main gear up-lock released prematurely, allowing the left main gear to drop on the door. This prevented the door from reaching full open position.

(b)

The mode change actuator retracted (shifted from VTOL to CTOL) simultaneously with gear door-open motion, rather than delaying until after gear-down VTOL position was reached.

Further tests verified the repeatability of these malfunctions, as follows:

(a)

Unintentional actuation of gear up-lock release occurs as a result of pressure spikes in the return line from mode change actuator motion. (The same condition results from combinations of wing fan door, diverter valve, and horizontal stabilizer actuation.) This is possible because the up-lock release actuator is single acting, and the pressure port is affected by return line pressure through the open centered (neutral position) control valve.

(b)

Out-of-sequence gear mode change actuation occurs as a result of improper operation of the gear down-and-locked indicator switches. This malfunction was caused by marginal switch actuator design, and improper adjustment of switch timing.

Corrective action consisted of increasing the spring load (in the latched direction) in the up-lock mechanism; installing a check valve in the hydraulic return line to eliminate downstream back pressure on the latch mechanism; and re-design of the indicator switch actuators to achieve positive adjustment and operation.

The Reliability Group also coordinated the following items:

(a)

For the silicone resin glass cloth laminate, a thermal life test was designed to determine characteristics of this duct shroud material. Specimens were exposed to temperatures from 600 F to 1000 F for 1 hour to 50 hours. Weight loss and flexural strength measurements were then made after exposure to this temperature environment. Subsequent analysis of test data showed the resin glass laminate material to be unacceptable under adverse operating conditions, and only marginally acceptable under normal operating conditions. Insulating blankets wrapped with stainless steel foil have now been installed in both aircraft.

(b)

The preliminary design of the pitch fan thrust reverser door damper was reviewed. The proposed design showed a single poppet valve in the reservoir piston. Due to the differential piston area of the working cylinder, the reservoir piston requires two (bi-directional) poppets. A configuration change was made before the design was released for manufacturing.

(c)

Engine ground test runs on Aircraft No. 2 were observed. The Reliability Group aided in the preparation of dismantling procedures and inspection requirements list for work to be performed on Aircraft No. 2 after completion of tests.

(d)

Redesign of the horizontal stabilizer control system (hydraulic-electric configuration) was recommended to improve reliability of "emergency trim" system, by making it a complete and separate electrical control system and physically located as close as possible to the hydraulic control valve. The system change was approved and is installed on both aircraft.

(e)

The test plan for the Simulator Failure Analysis Program was completed. Forty-five potentially catastrophic subsystem or component failure modes in 8 subsystems were investigated. Of the 188 failures introduced, 160 were considered valid test cases. Successful recoveries were accomplished for 140 failures, (87.5%). The remaining 20 failures, (12.5%), were considered crashes. A summary of the subsystems and components with the associated catastrophic failure modes are shown in Table 4. The percentages of failures resulting in crashes versus recoverable failures for these subsystems and components are included.

Failures were induced in three ways: by removing bolts from the simulator hardware, by manipulating the analog computer controls, and by installing control panels to simulate various electrical failures. Four electrical failure control boxes are shown in Figures 11 through 14. Figure 11 shows the stabilizer



control panel. This panel permitted simulation of all stabilizer directional and rate control valve, and rate sensing transducer failures. Figure 12 shows the control panel used to simulate switch failures in the thrust vector actuator programmer. Figure 13 and 14 show the two stability augmentation system failure control panels. Simulated louver servo-valve coil open and short circuits (Figure 13), and integrator cutout switch open and short circuits (Figure 14) were introduced by these panels.

(f)

Final arrangements were completed for the Flight Test Failure Reporting Program. (Reference Quality Assurance Bulletin Number XV10.)

TABLE 4 SIMULATED FAILURES SUMMARY

Subsystem or Component	Catastrophic Modes	Successful Recoveries		Crashes	
		Total	%	Total	%
Mechanical Mixers and Controls	1. Louver torque tube disconnected				
	2. Lift stick system disconnected	4	40 %	6	60 %
	3. Main to pitch mixer interconnect disconnected				
Gas Generators	1. Single engine failure	22	75.8%	7	24.2%
Horizontal Stabilizer, Hydraulics	1. #1 Directional control valve hard down				
	2. #1 Directional control valve hard up	39	86.7%	6	13.3%
	3. #1 Directional control valve up coil open				
	4. #1 Hydraulic flow rate transducer open				
Thrust Vector Actuator Programmer	1. Louver vector control close switch failed short	17	94.5%	1	5.5%
Remaining	None	78	--	0	--
TOTALS		160	87.5%	20	12.5%

2. Schedule

All reliability milestones were on schedule at the close of this reporting period.

3. Plans for Next Quarter

Plans for continuing next quarter include, (a) components and systems failure analysis and corrective action recommendations; and (b) continuation of information acquisition for the Flightworthiness Report.

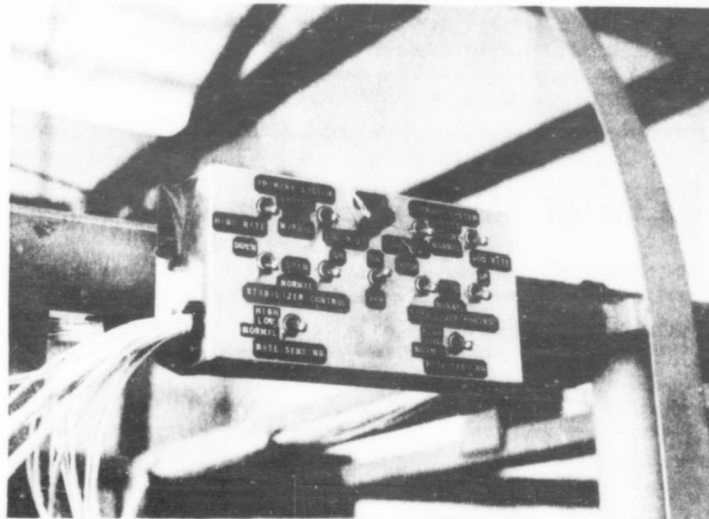
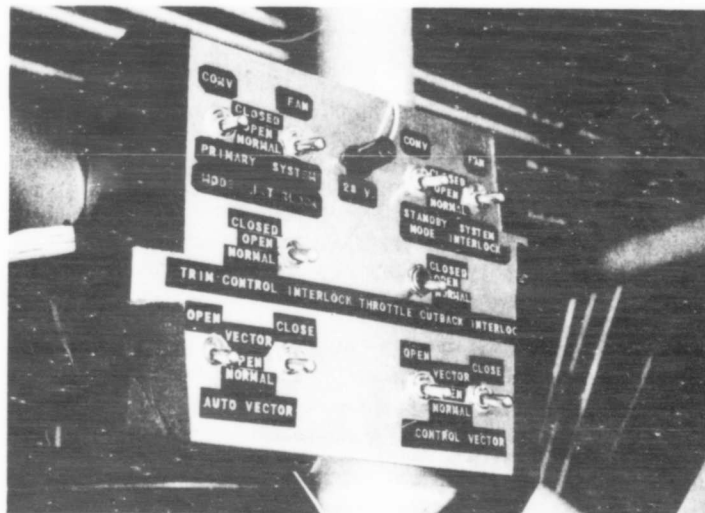


Figure 11 Stabilizer Control Panel



**Figure 12** Simulated Switch Failure Control Panel

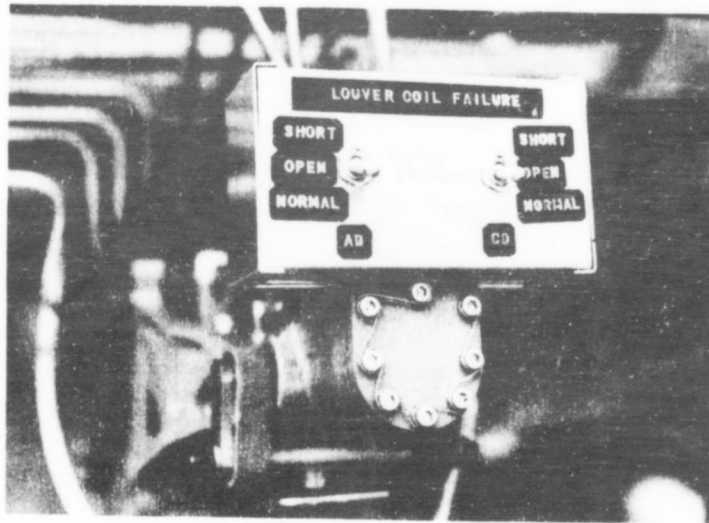


Figure 13 Simulated Louver Servo-Valve Circuit Failure Control Panel

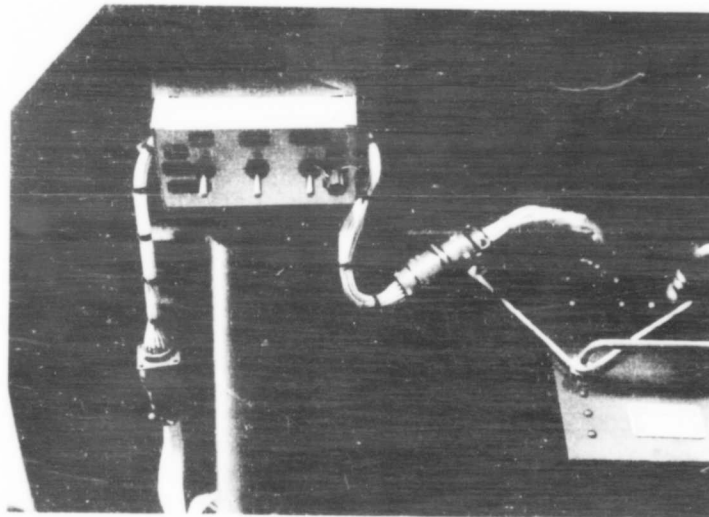


Figure 14 Simulated Integrator Cutout Switch Circuit Failure Control Panel

## G. STRUCTURAL AND SYSTEMS DESIGN

### 1. Progress

The structural and systems design effort involved support of ground testing at Ryan and liaison with the Edwards Air Force Base operation.

Detail problems discussed in this Report in Section III, Manufacturing and Section IV, Ground Test were solved by redesign and fabrication of components which permitted continued testing prior to aircraft shipment. In general, most of the problems encountered during ground test were from two sources:

The first source was caused by the extensive effort to minimize aircraft weight during design, therefore, some parts, although structurally sound from a strength standpoint, required additional stiffening due to dynamic deflections. Items, such as fairings, fuselage panels, etc. required stiffening for operation in the lift fan slipstream environment.

The second source was related to the installation of the lift fan system. Information obtained concerning fuselage thermal effects caused by the lift fan turbine exhaust required certain analysis estimates.

The problems outlined above, of course, are to be expected in new aircraft, using new concepts not utilized in the past.

The aircraft areas, which were designed without extensive past history, were heavily instrumented to identify problem areas before aircraft damage could occur. These instruments also supplied information for corrective action.

During the latter part of this period, nose wheel shimmy was investigated, and corrective design measures were accomplished. Ryan personnel maintained close liaison with the landing gear vendor in re-designing the nose gear fork and dampening assembly. Two computer programs were developed and correlation between them was established. The first was a digital program based upon WADC recommended analysis, and the second was a Ryan-developed analog program. The nose wheel analysis was finalized in the fabrication of a new nose landing gear fork assembly, and dampener, which met requirements on a spin test drum at speeds up to 125 miles per hour.

At the close of this reporting period, design effort was concentrated on a problem in roll control, which occurred during the initial hover test at Edwards Air Force Base. Areas of investigation included tests and analysis to determine necessary modifications to the hydraulic servo actuators which command louver position. Analysis was also conducted to determine the required increase in commanded roll control authority. NASA-Ames tests and additional Edwards tests will validate these design corrections.

2. Schedule

All groups were on schedule in supporting the flight test and the Ames test at the close of this period.

3. Plans for Next Quarter

The Structural and Systems Design Group will continue effort to resolve the roll control problem in conjunction with General Electric and NASA-Ames.

### III. MANUFACTURING

#### A. FABRICATION

##### 1. Progress

At the end of this reporting period, both ship No. 1 and No. 2 were completed. Ship No. 1 (Serial No. 24505) was delivered to NASA-Ames for test in the 40 foot x 80 foot wind tunnel. Ship No. 2 (Serial No. 24506) was delivered to Edwards Air Force Base. Figure 15 shows Ship No. 2 when it completed engine runs before shipment to Edwards. Aircraft during transit is shown in Figure 16.

The manufacturing effort during this period concentrated on ground test support. As problems were identified, which required repair or new parts, the manufacturing group responded on an around the clock schedule. Rapid response in supplying parts required during the ground test resulted in very little down time.

Items fabricated during ground test include:

- a. Temperature resistant landing gear fairings and main landing gear insulation (Figure 17).
- b. Chine strip on the aft fuselage (Figure 18).
- c. New bleed duct insulation.
- d. Tailpipe finger seals, (Figure 19).
- e. Revised aileron servo control valves.
- f. Added stiffening members to the cockpit floor.
- g. Added insulation to aircraft structure behind the tailpipe and around the pitch fan.
- h. Reworked pitch fan inlet louver linkage to increase stiffness.
- i. Revised throttle quadrant to improve backlash.
- j. Installed baffle and seal strips around pitch fan aft frame to air-frame horizontal seal.
- k. Installed dampeners on the pitch fan reverser doors.
- l. Added access doors to the canoe fairing.

Manufacturing also was involved in repairing the aircraft after a fire occurred in the center fuselage during fan mode operation on December 29, 1963.

Certain vendor-supplied equipment items required re-work and re-qualification. These included cooling fan gear boxes, exit louver mixer box actuator, and horizontal stabilizer actuator. All components were returned after re-qualification, and have operated satisfactorily to date.

At the close of this reporting period, the manufacturing effort was only in support of flight test, with spares and a few modified parts.

2. Schedule

The manufacturing effort is on schedule with flight test requirements.

3. Plans for Next Quarter

Due to the replacement of the exit louver actuators, the manufacturing group will supply flight test with required new parts for modifying the aircraft.





Figure 15 Ship No. 2 - Engine Runs Complete

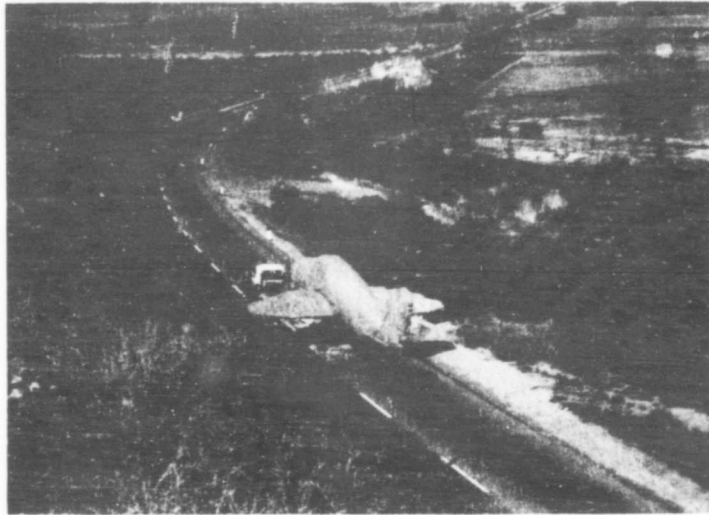


Figure 16 Aircraft in Transit to Edwards AFB

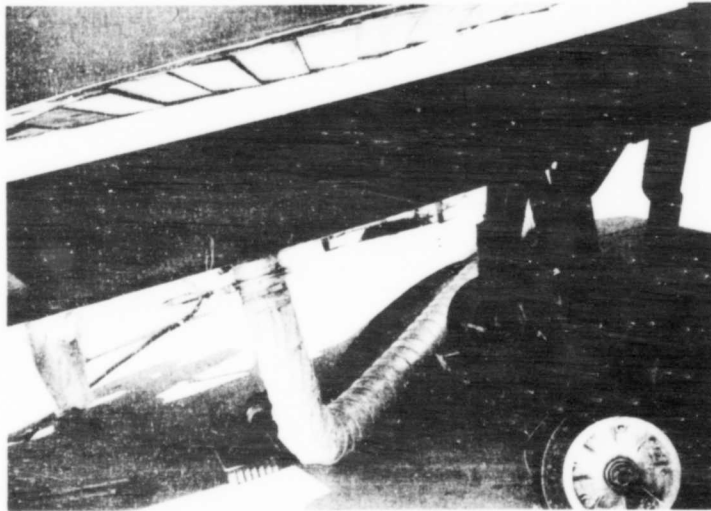
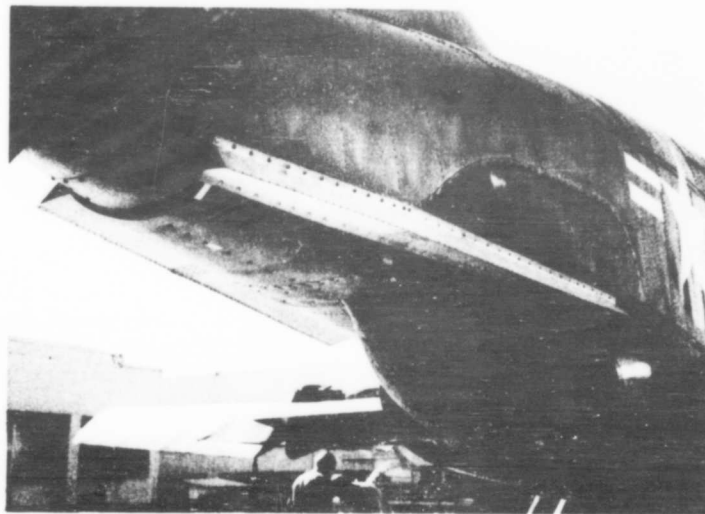
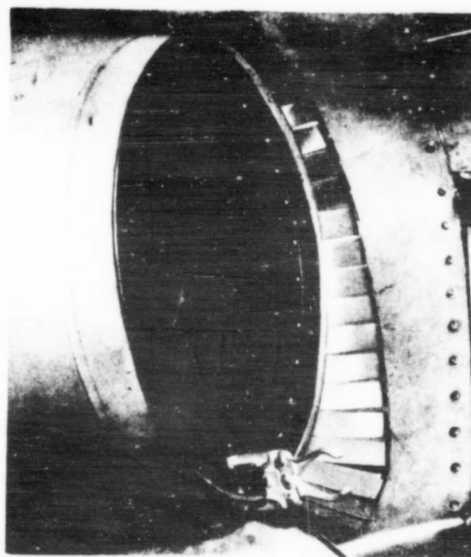


Figure 17 Landing Gear Insulation



**Figure 18** Chine Strip on Aft Fuselage



**Figure 19** Tailpipe Finger Seals

#### IV. GROUND TEST

##### A. TEST PROGRAM DEVELOPMENT

###### 1. Progress

Testing of re-worked components received from vendors continued, as well as test of supporting spares. As a result of these tests, it was determined that the horizontal stabilizer-actuator, as presently designed, could not meet the desired requirements. Therefore, a new supplier was obtained to furnish replacements prior to start of flight testing. This unit is now installed on both ships and the simulator, and in addition, the unit has been qualified.

During simulator operation, the fan-gear box assemblies failed. Re-designed units were installed in the simulator. These have now been operated approximately 150 hours with no difficulty.

All system testing of the hydraulic and control simulator confirmed its operation in preparation for simulation studies. The hydraulic pumps accumulated more than 200 hours of operation without performance degradation. Leaks in the accumulator and relief valves, and failure of the thrust vector actuator, caused some down time. However, during a one week period, the simulator-visual display-computer combination was operated for about 11 hours each day without breakdown. Two pilots flew the simulator. From their recommendations, modifications were made to control rates and stick forces. A total of 450 hours has been accumulated to date on the hydraulic and control simulator.

Ground resonance testing of the control surfaces on No. 1 aircraft completed the test requirements of Ryan Report No. 63B086. The final report of these tests, which includes analysis and mode shape definitions, is being prepared.

The installed systems functional tests per Ryan Report No. 63B102, XV-5A Installed Systems Functional Test Procedure was completed on both aircraft, with the exception the landing gear functional test on Ship No. 1, which is at NASA-Ames. This test will be conducted before first flight. The following paragraphs summarize the performed tests in the presentation sequence noted in Ryan Report No. 63B102.

All tests were conducted under surveillance of Ryan Quality Control and the XV-5A design team.

##### Test Results Summary

###### (a) Electrical System Checkout

The aircraft was tested as described in Section 3.1 of Ryan Report No. 63B102.

All systems operated per design requirements and the electrical system was cleared for flight.

During ground tests the need for several minor electrical system changes were identified:

Removal of the horizontal stability trim switches which are activated with stick displacement during hovering flight.

Relocating the emergency horizontal stabilizer trim relay to a location close to the stabilizer actuator.

These items will be incorporated at Edwards Air Force Base prior to transition flight. Both items were evaluated during the final simulation effort.

(b) Surface Gains and Hysteresis

Surface gain and hysteresis tests were performed. The following items were noted from the recorded data:

1. At maximum collective stick position, the LH Aft louver mixer mechanism encountered interference for a right wing down operation.
2. At minimum collective stick position, the RH Aft louver mixer mechanism encountered interference for right wing down operation.
3. Full rudder travel and full louver travel were not available for right yaw input from the rudder pedals.
4. The force required to move the collective stick in the up direction was approximately twice that required for the down direction.

The above discrepancies were corrected and re-tested. The results of all control surface gains and hysteresis tests were considered satisfactory.

(c) Flight Controls Stability

These tests were performed on aircraft S/N 24505 in accordance with the referenced test procedure section of Ryan Report No. 63B102 and the following deviations:

1. Lateral Stick to Aileron - CTOL Mode

The vibration was maintained at a double amplitude displacement of .20 inches from .5 cps to 30 cps, and the response curves were obtained.

As a result of preliminary tests, the aileron servo control valves were modified from an underlapped to an overlapped configuration and the longitudinal push rods to the aileron servos were stiffened. Re-tests of the lateral stick to aileron-CTOL mode met all design requirements.

2. Lateral Stick to Wing Fan Louver Servo

The over-all vibration response was determined by combining the responses from the lateral stick to the aileron droop mechanism crank input, and from the aileron droop mechanism crank input to the louver servos. This two-step operation was required to avoid excessive control acceleration and resulting damage to the mixer box.

As a result of initial tests, the cockpit floor was reinforced in the vicinity of the stick and the control pivot bracket. This test was repeated, with the stability characteristics meeting design requirements.

3. Longitudinal Stick to Pitch Fan Door Servo

The vibration at the stick was maintained at a double amplitude displacement of .22 inches. The dampening ratio found at 9 cps was approximately .0562 and at 30 cps was approximately .0281. These quantities were calculated from the frequency response curves. Although the dampening ratio at 30 cps is somewhat less than anticipated, no problem will occur because there is positive dampening.

4. Rudder Pedal to Wing Fan Louver Servo

The rudder control cables were disconnected aft of the forward cable tension regulator. The rudder pedals were removed and the vibration was applied to the pedal torque tube in the cockpit at a double amplitude of .24 inches. This procedure was followed to avoid damage to the rudder and to the rudder pedals caused by excessive controls accelerations.

Initial testing damaged the rudder pedals, which were replaced, and made it necessary to modify the yaw crank input to the mechanical mixer to a double bearing configuration. This test met all of the design objectives after completion of the modification.

5. Collective Control to Wing Fan Louver Servo

The vibration at the collective control was maintained at a double amplitude of 1.0 inch. This test indicated that the stability characteristics meet the design requirements.

## 6. Step Inputs

The transient (step input) tests were conducted as outlined in Ryan Report No. 63B102, Paragraph 3.3.6, except that a Sanborn Model 60-1300 recorder was used. Tests were:

Longitudinal stick to elevator CTOL mode.

- a. Natural frequency 8.13 cps down elevator, and 9.53 up elevator direction.
- b. Dampening ratio .0748.

Longitudinal stick to pitch control door servo.

- a. Natural frequency 8.0 cps. Down elevator, and 10.0 cps up elevator direction.
- b. Dampening ratio .070.

Rudder pedal to rudder CTOL mode.

- a. Natural frequency 8.19 cps right rudder, and 7.69 cps left rudder direction.
- b. Dampening ratio .0459.

Rudder pedal to L/H aft louver servo.

- a. Natural frequency 8.70 cps.
- b. Dampening ratio .0556.

### (d) Flight Mode Conversion Sequence

The pitch fan inlet louver position was not recorded because the louvers had been removed for re-work when the test was conducted on Ship No. 2. The pitch fan inlet louver position was recorded on XV-5A aircraft No. 1, and successfully met the design objectives. The diverter valve transient time was determined while converting from VTOL to CTOL position only on XV-5A aircraft No. 2. The diverter valve transient time was determined both ways.

These tests were also conducted during engine runs at 70% rpm on both engines and on primary and standby electrical power. The tests were repeated at 90% rpm on both engines on primary electrical power only.

Conversion abort tests were also successfully conducted at 70% rpm on both engines, which also tested all safety interlock functions preventing conversion if any conversion components are malfunctioning.

(e) Cockpit Checkout

The cockpit checks were conducted to demonstrate the operation and adequacy of the pitot-static system, throttle, canopy lock, and spin chute installations. All systems performed per design requirements.

1. Pitot-Static System

All pressure sensing switches and instruments were removed from the pitot and static lines and both lines were checked for flow, and subsequently pressure tested to 20 psig.

The landing gear warning pressure switches were placed in the system and were found to operate as prescribed.

The pilot's seat speed sensor arming switch was tested to manufacturer's specifications in the laboratory and an operational check was made. All functions were normal. Pressure sensing instruments were calibrated in the laboratory and checked for normal operation in the aircraft. The ejection seat system will be tested again at the time pyrotechnics are installed before the first flight.

Tests of the VTOL mode air-speed system resulted in slight changes to that system. A calibrated bleed and a restrictor were added in order that sudden changes in pitot pressure, at the time of mode change, would not overdrive the air-speed indicator. The resulting system produces a one-to-two knot drop in indicated air-speed during VTOL operation.

2. Power Quadrant and Engine Controls

Both engine throttle systems were checked individually and collectively. Slight discrepancies in throttle lever friction clutching were noted but were corrected through proper adjustment of the friction mechanism. Twist grip torque was within the limits specified by design. Twist grip rotation and resulting throttle lever displacement were as specified.

3. Canopy Latch

Canopy down lock and intermediate stops were checked for compliance with design requirements. The down lock lever secured the canopy against the canopy seals with shear pins engaging the receivers. The down lock was positive with only moderate latch lever forces required.



4. Drag Anti-Spin Chute

Deployment of the spin chute was checked and found to be satisfactory. Jettisoning procedures were tested with no discrepancies noted.

5. Automatic Throttle Cutback

Automatic throttle cut-backs resulting from fan overspeed were tested. Overspeed signals were simulated using General Electric test equipment. Throttles were in the 90% rpm position and a conversion from CTOL to VTOL flight mode was made. As the wing fan louvers passed through 45°, the pointers on the engine fuel control boxes cut back to approximately the 70% rpm position. The throttle cutback switch reset the pointers to the original 90% rpm position.

The system was also operationally checked during engine run tests.

(f) Engine Run Temperature Survey

This series of tests was run as described in the following paragraph, and shown in Figure 20. On occasions, local over-temperature conditions were experienced and modifications were incorporated to remedy the situation. These modifications are discussed in the applicable paragraphs. Internal instrumentation was recorded in the instrumentation shack using recorders and visual monitoring equipment, (Figures 21 and 22).

1. Ignition Test

The ignition switch was turned on (for each engine individually) for approximately 10 seconds. Both ignitors were audible.

2. Motoring Test

Each engine was turned over several revolutions by hand. No rubbing, dragging or unusual sounds were noted. Each engine was then motored with the air-start cart at 15% rpm and fuel flow checked. No problems were encountered. Engine run-down times were logged for each subsequent engine operation.

3. Idle - CTOL

The engines were run at idle rpm for approximately five minutes individually in the CTOL mode. A leak check and general inspection was performed during this run.

4. Single Engine Power Run - CTOL

The engines were run individually in the CTOL mode to 98% rpm in the

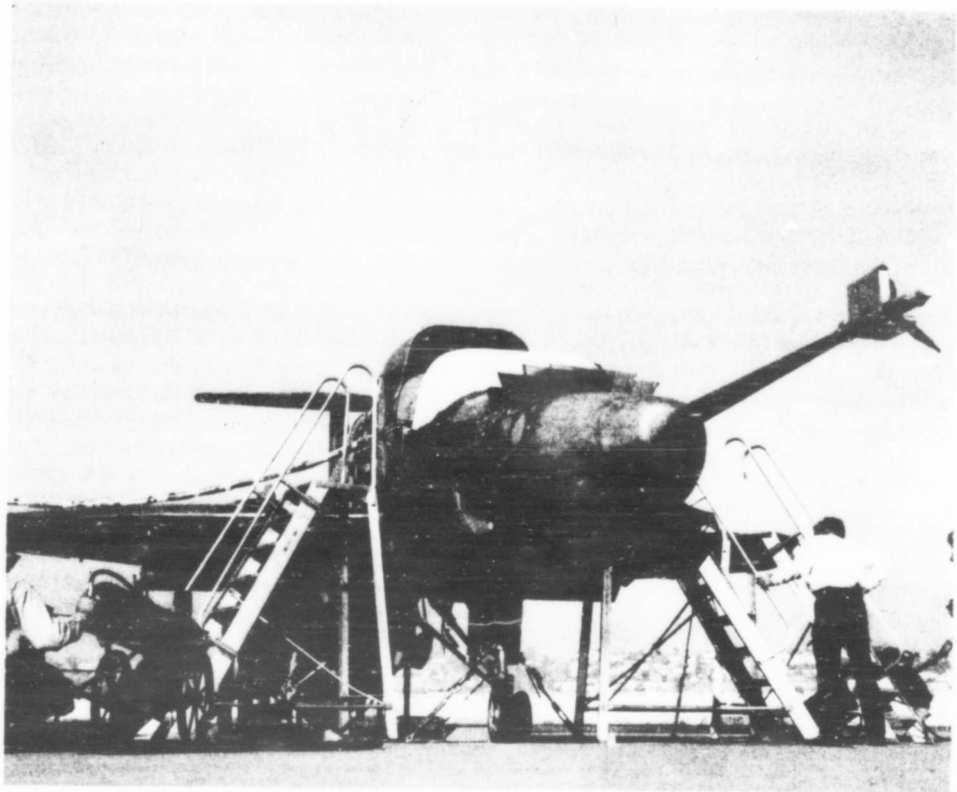


Figure 20 Engine Run Temperature Survey

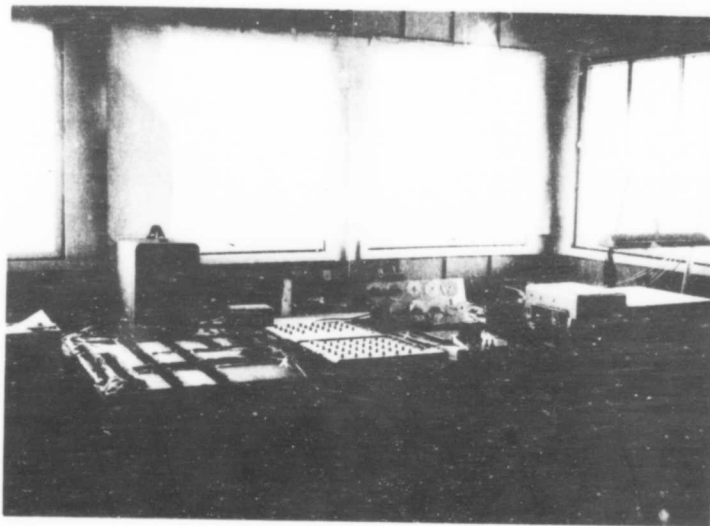


Figure 21 Engine Run Instrumentation Survey

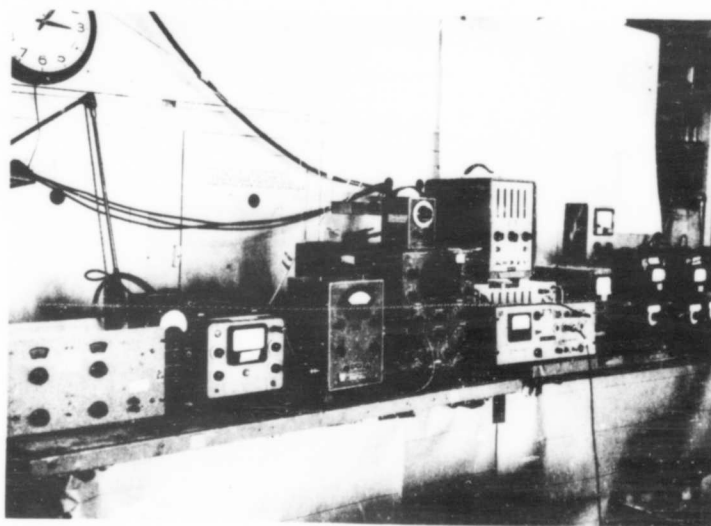


Figure 22 Engine Run Instrumentation Survey

following increments: 48%, 70%, 80%, 90%, 95% and 98%. Higher rpms's were not obtainable because of a throttle adjustment. Each power setting was held until the EGT stabilized (approximately 10 seconds).

5. Single Engine Idle - VTOL

The engines were run individually at idle for approximately five minutes in the VTOL mode at  $\beta_v = 0$ .

6. Single Engine Power Run - VTOL

The engines were run individually in the VTOL mode to 98% rpm in the following increments: 70%, 80%, 90%, 95% and 98%. Higher rpm's were not obtainable due to improper throttle adjustment. Each power setting was held until the EGT stabilized.

7. Dual Engine Power Run - CTOL

The engines were run simultaneously in the CTOL mode to 100% in the following increments: 48%, 70%, 80%, 90%, 95%, 98%, 99%, and 100%. Each power setting was held for approximately three minutes up to 100% rpm which was held for five minutes for heating criteria compliance.

The lower fuselage skin just aft of the tailpipe openings was overheated during dual engine runs. The damaged skin was replaced and the existing external insulation was extended to cover the area.

Chine rails were also installed on both sides of the aft fuselage to prevent hot gases from washing the upper aft fuselage.

8. Dual Engine VTOL Power Runs

<u>Power Setting (%)</u>	<u>Mode</u>	<u><math>\beta_v</math></u>	<u>Time (Minutes)</u>
70	VTOL	0°	2
70	CTOL		2
70	VTOL	-5°	2
70	CTOL		2
70	VTOL	20°	2
70	CTOL		2
70	VTOL	40°	2
70	CTOL		2
90	VTOL	0°	2
70	CTOL		2
90	VTOL	20°	2
70	CTOL		2
90	VTOL	30°	2

<u>Power Setting (%)</u>	<u>Mode</u>	<u><math>\beta_v</math></u>	<u>Time (Minutes)</u>
70	CTOL		2
90	VTOL	40°	2
70	CTOL		2
95	VTOL	0°	2
70	CTOL		2
95	VTOL	20°	2
70	CTOL	20°	2
95	VTOL	30°	2
70	CTOL		6
95	VTOL	40°	2
70	CTOL		2
100	VTOL	0°	1/2
70	CTOL		2
100	VTOL	20°	1
70	CTOL		2
100	VTOL	30°	1/2
70	CTOL		2
100	VTOL	40°	1
70	CTOL		2

During dual engine operation at idle in VTOL and  $\beta_v = 0^\circ$ , a fire occurred in the cross-over duct insulation just below the diverter valves. Both engines experienced over-temperature condition during this run and consequently were pulled and inspected.

Due to this condition, the engines will not be run under 70% rpm at any time in the VTOL mode.

As  $\beta_v$  was increased during subsequent VTOL runs, high temperatures were experienced in the main wheel well area and landing gear struts. The main landing gear was then wrapped with insulation and the wheel well area was enclosed. No further over-temperatures occurred in these areas.

Some pitch fan scroll leakage was evidenced, and a seal and baffle strip were installed on the fan scroll as a fix. Additional insulation was also installed in the pitch fan area between the fan and aircraft structure.

As  $\beta_v$  was increased in the VTOL mode, the thrust reverser doors and inlet louvers developed an oscillation. The louver linkage was modified and a dampener was installed on the exit doors. Subsequent tests were successful.

Access doors were added in the engine cover and canoe for faster fire protection and inspection purposes.

### 9. Thrust Spoiler Test - Dual Engine

The thrust spoiler test was run in CTOL mode with both engines as follows:

<u>Power Setting (rpm)</u>	<u>Spoiler Position</u>	<u>Time</u>
90%	12 1/2%	30 Sec
↑	25%	↑
↓	37 1/2%	↓
90%	50%	30 Sec
70%	62 1/2%	2 Min
95%	Retracted	30 Sec
↑	12 1/2%	↑
↓	25%	↓
95%	37 1/2%	30 Sec
70%	50%	2 Min
100%	62 1/2%	30 Sec
↑	Retracted	↑
↓	25%	↓
100%	50%	30 Sec
↑	75%	↑
↓	100%	↓
100%		30 Sec

At the conclusion of the 95% rpm runs, the titanium aft center fairing was replaced with a heavier gage material, due to cracking of the original installation.

Exhaust gases entered the fuselage tail pipe opening around the shrouds causing the structure to reach temperature limits. Stainless steel finger seals were installed in this opening which resolved the temperature problem.

The fuselage Fiberglas insulation also frayed out just aft of the tail pipe opening during 100% rpm and 50% spoiler. This was replaced by .016" stainless steel over Min-K insulation.

### 10. Single Engine Diverter Valve Tests

This test was successfully run as follows:

<u>Mode</u>	<u>L/H Eng. rpm</u>	<u>R/H Eng. rpm</u>
CTOL	90%	70%
VTOL	90%	70%
CTOL	95%	70%
VTOL	95%	70%

<u>Mode</u>	<u>L/H Eng. rpm</u>	<u>R/H Eng. rpm</u>
CTOL	100%	70%
VTOL	100%	70%
CTOL	70%	100%
VTOL	70%	100%

#### 11. Pitch Fan Thrust Reverser Test

With both engines at 100% rpm in VTOL mode and  $\beta_v = 0^\circ$ , the control stick was moved rapidly from extreme forward and aft positions to center and from half forward and aft positions to stop and center. (Both directions from each position.) Some pitch fan exit door flutter was experienced while at the aft stick positions. Dampeners were installed on both pitch fan exit doors and were tested successfully on both XV-5A aircraft.

#### 12. Flight Mode Conversion

The automatic trim switches were de-activated during this test due to design group's request. Simulator tests indicated that these switches are unnecessary, and they were deleted.

Conversions were made from CTOL to VTOL and from VTOL to CTOL at 70% and 90% engine rpm. An abort from CTOL to VTOL and from VTOL to CTOL was also accomplished at 90% engine rpm.

#### 13. Fan Overspeed Cutback

Performance of the Fan Overspeed Cutback system was satisfactory in all respects. With engine run experience obtained after the noted modifications, it is felt that the XV-5A can be flown with the minimum of risk due to temperature problems. It should be noted that the heating compliance tests are not entirely applicable to clearing the aircraft in forward flight. The XV-5A is adequately instrumented to determine powerplant operational adequacies of the aircraft during forward flight.

#### (g) Engine Run Electrical Systems Checkout

The electrical system checkout performed satisfactorily as outlined in the referenced Test Procedure with the exception of the battery test. The battery test was performed later just before first flight.

#### (n) Auto-Stabilization Tests

Auto-stabilization tests as specified in Ryan Report No. 63B102 were completed satisfactorily.

In addition to the tests specified, frequency response tests were made on the wing fan exit louver actuators and pitch control door actuator for roll, yaw, and pitch inputs to the amplifier.

During checkout, an instability of the pitch system was observed for gain settings above "4" on the pilot's gain control panel. The frequency of oscillation was determined to be 14 cps and was the result of body bending disturbing the gyro package in response to pitch door motion. A filter network was subsequently installed in the amplifier which eliminated the oscillation.

(i) Fan Flight Trim Rates

The tests were performed in accordance with referenced Test Procedure Section of Ryan Report No. 63B102. Horizontal stabilizer rate produced by longitudinal stick position was not obtained because this control function was discontinued. The emergency trim system was tested and was found to be functioning properly.

The following are the trim rates found:

1. Pitch Control Door  $2.39^{\circ}/s$ ,  $\beta_v = 0$
2. Horizontal Stab.  $3.98^{\circ}/s$ ,  $\beta_v = 30$
3. Horizontal Stab.  $1.15^{\circ}/s$ , CTOL
4. Horizontal Stab. during conversion  $6.51^{\circ}/s$ , #1 Hyd. System
5. Horizontal Stab. during conversion  $7.52^{\circ}/s$ , #2 Hyd. System
6. Horizontal Stab. during conversion  $6.42^{\circ}/s$ , Both Systems
7. Horizontal Stab. during conversion  $7.99^{\circ}/s$ , Engines On
8. Roll Trim LH Wing  $.652 \text{ Deg } \beta_s/\text{Sec}$
9. Roll Trim RH Wing  $.719 \text{ Deg } \beta_s/\text{Sec}$
10. Yaw Trim LH Wing  $.949 \text{ Deg } \beta_v/\text{Sec}$
11. Yaw Trim RH Wing  $.855 \text{ Deg } \beta_v/\text{Sec}$
12. Trim Transfer Point  $\beta_v = 16 \text{ Degrees}$
13. Thrust Vector Actuator  $3.79 \text{ Deg } \beta_v/\text{Sec}$

(j) Landing Gear Tests

The landing gear functional tests were conducted to demonstrate the sequencing



and operation of the landing gear in both the normal and emergency systems. These tests were performed on aircraft No. 2 and will be repeated on aircraft No. 1 after wind tunnel tests.

1. Brake Check

Brake checks were performed per vendor specifications and brakes were found to be properly installed and adjusted.

2. CTOL Mode Landing Gear Functional Test

The aircraft was prepared for test by being placed in the CTOL flight mode, and with the landing gear in the down (forward) position. The gear was cycled through the use of the landing gear selector switch in the cockpit. Retraction and subsequent extension of the gear was normal in all respects. Cockpit position indicators and warning horn and light operation were normal.

3. VTOL Mode Main Landing Gear Functional Test

The aircraft was placed in the VTOL flight mode with the landing gear in the down (aft) position. The gear was cycled through the use of the landing gear selector switch in the cockpit. Retraction and extension of the landing gear was normal. Cockpit position indicators and warning horn and light operation were normal.

4. Downlock Over-ride Check

The main landing gear wheels were placed on blocks which allowed the downlock Microswitch to open and require use of the over-ride button to bring the landing gear up. Each wheel was tested individually and then together. In each case, the over-ride button had to be used to select the UP position on the switch. Retraction from that point was normal.

5. STOL Over-ride

The aircraft was placed in the VTOL flight mode with the landing gear down. The STOL over-ride switch was placed in the STOL position, and the landing gear moved to the CTOL position. Landing gear position indicators operated normally and the STOL warning light illuminated. Returning the over-ride switch to "Normal" returned the landing gear to the VTOL position. Indicators and light returned to the normal state.

6. Landing Gear Retraction Under Load Factor

The main landing gear was cycled while under a simulated inertia load

of 1-1/2 g's. Lead shot bags were placed along the landing gear struts so that the simulated load acted at the original landing gear center of gravity. No discernible changes in gear retraction or extension were noted.

7. Emergency Pneumatic Extension System

The landing gear was extended several times under various pneumatic pressures.

No load extensions were made along with minimum pressure and maximum airload extensions. The tests showed the requirement for increasing the diameter of the restrictor orifice in the emergency system from the original .0105 inch diameter to .0156 inch diameter. This change resulted in much better extension rates, and more positive stops at the travel limit.

Extensions using 1700 psig nitrogen pressure and with the main landing gear under a simulated drag load of 170 pounds per side were made with times and rates well within the established design limits. The nitrogen system low pressure warning light illuminated at 1675 psig per design requirements.

8. VTOL - CTOL Mode Change - Aircraft Resting on Its Own Wheels

This particular portion of the functional test has not been accomplished to date. This has come about as a result of landing gear and landing door modifications made during engine runs. The mode change test will be accomplished, however, prior to flight-required mode change at the flight test facility.

(k) Controls Proof Loads

The controls proof loads test was run as outlined in the following paragraphs. All loads were applied by hydraulic cylinders with the exception of the lateral stick and collective control stick. These loads were applied by hand using a spring scale or by dead weight.

1. Rudder - CTOL

The rudder was restrained in the neutral position and the 300-pound test load was applied to each rudder pedal individually.

2. Elevator - CTOL

The elevator was restrained in the neutral position and a 200-pound load was applied forward and aft to the control stick grip.

3. Aileron - CTOL

The aileron tabs were restrained in the neutral position and a 100-pound load was applied laterally to the control stick grip in both directions.

4. Elevator Cable Stretch - CTOL

In VTOL mode, the control stick was restrained in the full aft position by a 150-pound force. With the horizontal stabilizer in the full L.E. down position, an increasing down load was applied to the elevators until the control stick just cleared the aft stop. The elevator moved down 6 degrees before first movement of the stick occurred.

5. Throttle Test

A 75-pound aft load was applied to both throttles (separately) with the load reacted by bottoming of the lower throttle mechanism.

6. Collective Control Stick

The collective control stick was loaded to 150-pounds in both the up and down directions. Loads were reacted by bottoming of the stick mechanism in the cockpit.

7. Control Stick and Rudder Pedals - VTOL

In the VTOL mode, the control stick and rudder pedals were displaced to their extreme positions (separately) with hydraulic pressure on and held firmly as hydraulic power was shut off. A spring scale was used to pull the stick or rudder pedal in the opposite direction to which it was originally displaced, and the force to bring it to the opposite cockpit stop was recorded.

During lateral stick loading, the control stick pivot tube pulled out of its aft bearing support. A fix was made and the load test was successfully completed.

(1) Weights - Balance and Fuel Tests

The weight and balance tests on aircraft No. 1 were run to determine total aircraft weight and the variation in center of gravity position with various fuel quantities.

The aircraft landing gear was placed in the VTOL (aft) position and all installed equipment was in place or simulated. The aircraft was placed on standard aircraft scales and leveled for the empty weight measurements.

Forward fuel tank quantity and center of gravity measurements were run as installed in the aircraft. The aft main and dorsal tanks were calibrated out of the aircraft in special holding fixtures. Fuel centers of gravity were obtained on all tanks for the following pitch attitudes:

Level,  $\pm 5$ ,  $\pm 10$ , and  $\pm 15$  degrees.

1. Empty Weight - Aircraft Level

The aircraft was positioned as noted in Figure 23. A survey of installed equipment showed the following items to be missing:

Fiberglas flap hinge fairings

Throttle quadrant cover

Annunciator panel

Signal Conditioner box

Telemetry box

Seat mode speed sensor

Engine compartment cooling fans and gear boxes (20-pounds of lead shot were added at each fan and gear box location to simulate component weights)

Heat shield modification for main landing gear

Chine rail installation above tailpipe exits and modification to original Min-K insulation installation in the tailpipe area.

Pilot seat rocket motor.

The net weight, not including the above items, was 7,874 pounds. The center of gravity at this weight was located at F.S. 245.52, W.L. 117.48. Omitted aircraft components were compensated for using the IBM weight and balance computer program, with the empty weight established at 7,541 pounds.

2. Fuel Quantities - Level Attitude

The following fuel quantities were required to fill the tanks indicated:

Forward Fuselage Tank:	1600 pounds
Aft Main Tank:	830 pounds*
Dorsal Tank:	797 pounds

\*Slightly more fuel may be placed in this tank when installed in the aircraft as it will be filled through the dorsal tank and may be filled completely. During testing, the tank was filled through its own filler cap, which will not allow the tank to become completely filled.

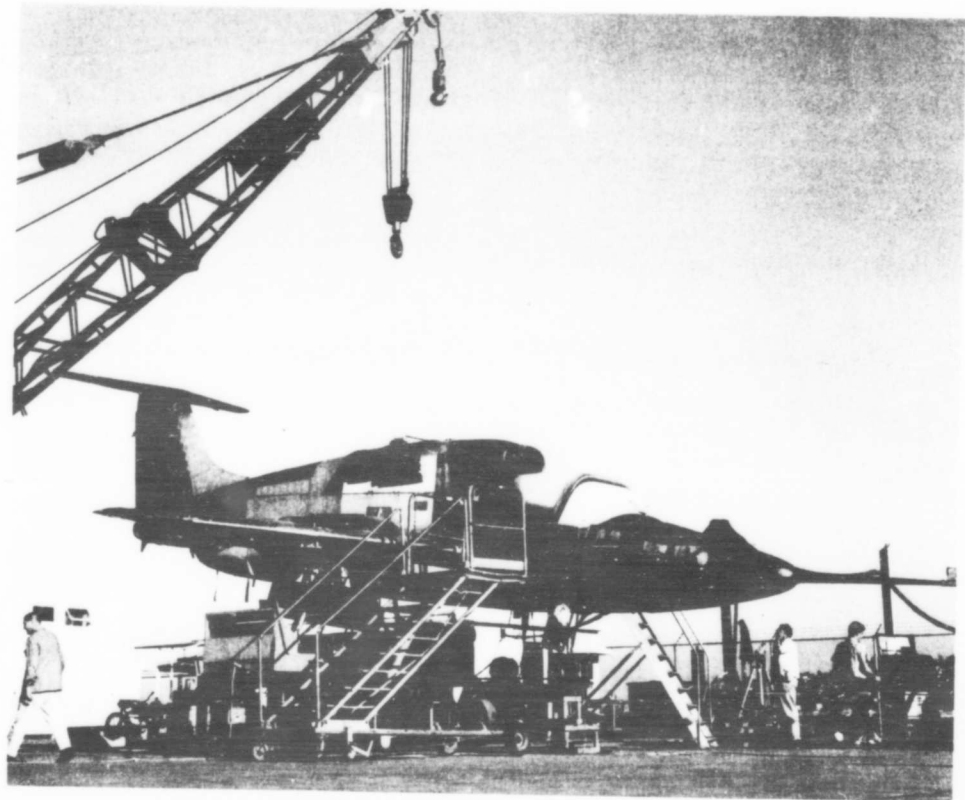


Figure 23 Empty Weight Determination of Aircraft

2. Schedule

All ground tests, with the exception of the main landing gear positioning tests, have been completed.

3. Plans for Next Quarter

The final installed systems functional test report will be completed. Ground test support for the wing fan and wing fan exit louver redesign effort will be conducted as required.

Ground testing will be arranged as required to support the flight test operation.

## V. FLIGHT TEST

### A. TEST PROGRAM DEVELOPMENT

#### 1. Progress

Instrumentation installation was completed in both aircraft. The PCM and photopanel units were completed. Signal conditioning equipment to provide compatibility between transducers and recorders, or telemetry and power supplies, was completed. Pre-flight instrumentation checkout was completed.

Both pilots received helicopter flight time in several types of helicopters at Ft. Rucker. Both pilots also checked out in the X-14 at Ames and also in commercial helicopters. They completed the final simulation studies and operated the aircraft during ground tests. With rollout of ship No. 2, both were ready to start flight testing (Figure 24).

The Detailed Flight Test Program, Ryan Report No. 63B001, and the Detailed Flight Test Procedures Report, Addendum I to 63B001, were submitted for final approval. Minor revisions to both of these documents were made and approved as Revision B.

Flight simulation was started on December 4, 1963 and was completed during this reporting period. Flying qualities in hover, conventional, and during transition were investigated. Both pilots received extensive experience in emergency situation simulation, and emergency procedures were developed.

The Flight Test Group assisted in the ground test engine runs and control systems tests. Data to support flight test was accumulated during these ground tests, and from the flight simulator. Simulator data was reduced and analyzed for comparative purposes with flight test data as it became available.

The No. 2 XV-5A test aircraft, S/N 62-4506, departed from San Diego by truck on 27 February, (Figure 25) and arrived at the General Electric Flight Facility at Edwards Air Force Base on 28 February.

Engineering test and project personnel arrived at Edwards AFB on 2 March to support the flight test program.

The test aircraft entered into an extensive work period on 2 March, which extended until 17 March. During this period, various work items were accomplished and the instrumentation functional checkout and calibrations were begun.

Thermocouples, requested by the XV-5A design groups, were wired into the thermocouple commutator and were checked out. The pulse code modulation (PCM) package were all installed and checked out. Initial compatibility and noise problems



Figure 24 Start of Flight Testing



were resolved. All required parameters were calibrated on both PCM and telemetry.

The first engine runs at Edwards were made on 17 March in the conventional mode to check for fuel leaks and proper engine operation. Test results were satisfactory.

The first engine runs in fan mode, (Figure 26), were made on 18 March to check fan operation and stability of the reworked pitch fan inlet louvers. Engine-fan operation was satisfactory, but vibratory motion of the pitch fan inlet louvers was unacceptable at engine speeds above 95% rpm. The inlet louvers were re-rigged and characteristics were found to be satisfactory.

The first weighing of the aircraft was conducted at the AFFTC Weights and Balance Hangar on 18 March.

Initial low speed taxi operations were conducted in the conventional flight mode on 21 March to check out braking and aircraft taxi characteristics. Brake fade was encountered, and was attributed to the wearing-in process of new pucks and discs. Low speed ground maneuverability was satisfactory.

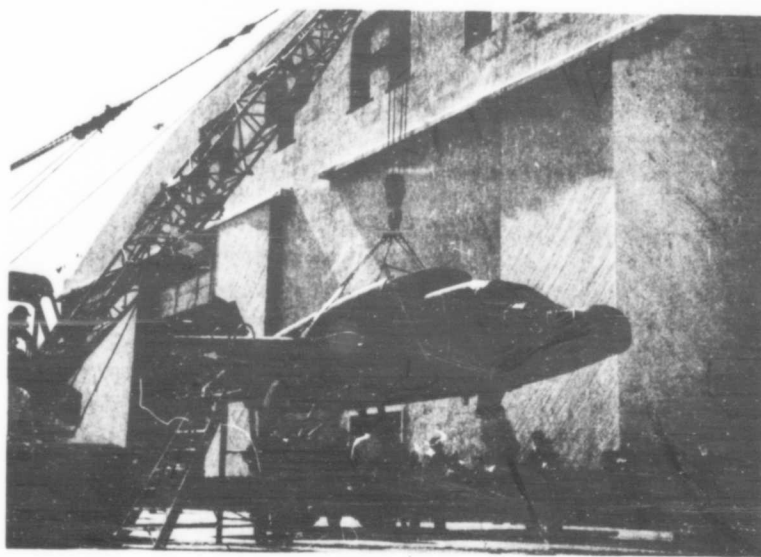
The aircraft entered a period of scheduled lay-up for accomplishment of additional work items during the period from 23 to 27 March. The landing gear doors were re-worked to permit capability of operation in either the VTOL or CTOL fixed extended position. Fan cavity instrumentation was also added, and other maintenance items were accomplished.

A low speed conventional taxi operation was conducted on 30 March. Ground handling characteristics were good, and no brake fade was encountered.

The initial hovering test was attempted on 31 March. The aircraft was momentarily airborne, but the inability of the pilot to maintain a wings level attitude caused an early termination of this test. The initial debriefing revealed that the use of full collective lift produced a significant reduction in the roll control authority, per design information.

Ground tests were then conducted in the VTOL mode on 6 and 7 April to determine wing fan exit louver operation at various engine power settings with the aircraft restrained in the tie-down area. Test results indicated a considerable decrease in wing fan exit louver stagger angles as engine rpm was increased. Test data indicated that a large percentage of louver motion resulted from the inability of the louver actuators to maintain a desired setting as engine power was increased. One actuator was removed from the aircraft and was tested in a load cell. It performed according to its design specification.

Three additional VTOL ground tests were conducted on 14 April to determine louver actuator loads, with the aircraft restrained in the tie-down area. Fixed steel rods, with strain gage instrumentation, were installed in the aircraft in lieu of the left hand wing fan louver actuators. Loads were measured



**Figure 25    Aircraft No. 2 in Transit to Edwards AFB**



**Figure 26    Engine Run in Fan Mode**

at 70, 90, 95 and 100 percent engine rpm. Photographic coverage of wing fan exit louver positions was also obtained during these tests. The recorded loads were considerably in excess of the capacity of the tandem hydraulic actuators. These test results precluded any further hover testing with the original 1500 pound p.s.i. hydraulic system capacity louver actuators.

The initial high speed taxi test was conducted on 8 April. Abrupt onset of nose-wheel shimmy was encountered at approximately 40 knots. The test was successfully aborted with no resultant damage to the test aircraft. An inoperative shimmy dampener was suspected. The dampener was shipped to the vendor for inspection and repair.

The shimmy dampener was returned from the vendor with a certificate of acceptability for its installation and use on the test aircraft.

The second high speed taxi run was conducted on 15 April. Abrupt onset of nose-wheel shimmy was again encountered at approximately 40 knots. Immediate action was taken to bring the aircraft to a stop, however, the nose wheel axle support flange failed; the nose-wheel separated from the nose-wheel fork; the fork dragged along the lake-bed and the drag link failed, causing the nose gear to collapse. This resulted in extensive damage to the nose section of the aircraft, forward of the cockpit.

The period from 15 April to 14 May was spent in repairing the damage to the airplane sustained during the incident of 15 April.

A redesigned nose landing gear, dampener, and linkage was shipped to the Lockheed Spin Test Facility on 7 May. Tests were conducted at speeds up to 125 knots and with excitation up to 25 cps with no indication of accompanying nose-wheel shimmy.

Total engine ground time on XV-5A S/N 62-4506 to 14 May was 5 hours 48 minutes, which included 1 hour 51 minutes of fan operation.

## 2. Schedule

Flight test operations are behind schedule due to the nose landing gear shimmy problem and the fan flight roll control problem. Emphasis will be placed on scheduling conventional flights within current flight restrictions.

### 3. Plans for Next Quarter

Shake tests of the redesigned nose landing gear are to be conducted with the gear installed on XV-5A aircraft S/N 62-4506 at Edwards AFB. High speed taxi and nose-wheel lift-off tests will be resumed after satisfactory completion of these shake tests.

The first phase of flight testing is presently programmed to investigate low speed conventional flight characteristics. This phase of testing will be limited to airspeeds less than 180 knots. Handling qualities and stability and control will be evaluated with the aircraft in the conventional configuration and in the pre-conversion configuration:

Pitch Fan Inlet Louvers	Open
Pitch Fan Exit Doors	Open
Wing Fan Inlet Doors	Closed
Wing Fan Exit Louvers	45 Degrees
Wing Flaps	45 Degrees
Landing Gear	Extended

Aircraft S/N 62-4506 will then be scheduled for programmed lay-up for fan rework. This schedule is contingent upon satisfactory completion of tests, to determine the adequacy of the revised wing fan and hydraulic louver actuators, which are to be completed in San Diego. An additional factor, which will greatly influence the schedule for resumption of hover testing, will be the results of the wind tunnel tests at NASA Ames to determine roll control authority in fan mode of operation.

Upon satisfactory resolution of the nose landing gear and the fan mode roll control problems, it is anticipated that the XV-5A flight test program can then be conducted in the manner outlined in the Detailed Flight Test Program. It must be recognized that changes in schedule will be forthcoming in view of the problems encountered to date, and also that changes in test sequencing may be necessitated by test results which are still forthcoming.

# VI. MILESTONE COMPLETION SUMMARY

<u>Number</u>	<u>Milestone</u>	<u>Revised Planned Date</u>	<u>Actual Date</u>	<u>Anticipated Date</u>
83A	Government approval of detailed flight test plan	11-26	3-25-64	
76.0	Complete systems function test #1 A/C	12-4	2-25-64	
76.1	Complete engine run and modify A/C #1 as result of ground tests	12-11	3-14-64	
60.0	Completion of No. 1 A/C ready for full scale wind tunnel test	12-19	3-14-64	
60.1	Ship No. 1 A/C to NASA Ames	12-19	3-23-64	
77.2	Complete system functional test No. 2 A/C	12-19	2-25-64	
81	Complete fabrication or procurement of all ground support equipment	12-20	12-6-63	
64	Install flight test instrumentation in No. 2 A/C	12-27	1-19-64	
79.0	All flight clearance reports submitted for low speed fan conventional flight	12-31	3-20-64	
77.3	Complete engine run and modify A/C No. 2 as result of ground tests	1-3	2-25-64	
62.0	Ship No. 2 A/C to Edwards AFB	1-8	2-27-64	
85	Start Flight Test Program	1-10	3-21-64	
62.1	No. 2 A/C ready for ground and taxi tests	1-11	2-25-64	

<u>Number</u>	<u>Milestone</u>	<u>Revised Planned Date</u>	<u>Actual Date</u>	<u>Anticipated Date</u>
94	Deliver Instructions for Operation and Maintenance of Airplane and Sub-system	1-15		7-3-64
77.4	Complete thrust stand and VTOL pre-flight tests on No. 2 A/C	1-17		7-3-64
74	Complete fabrication of test fixtures and equipment required for full scale wind tunnel test program	1-20	3-23-64	
79.1	Request clearance for No. 2 A/C for low speed fan and conventional flight	1-20	3-16-64	
79A	Government approval and low speed flight clearance of No. 2 A/C	1-27	3-28-64	
86	Demonstrate hover - first attempt	2-2	3-31-64	
70	Complete full scale wind tunnel test No. No. 1 airplane	2-21	6-17-64	
68	Complete a simulation study based on inputs derived from engineering analysis and scale model wind tunnel tests to provide predicted flight characteristics	2-15	2-24-64	
70.1	No. 1 airplane returned for flight test	2-29		- - -
79.2	All flight clearance reports submitted for high speed conventional flight	2-29		8-20-64
78	Request flight clearance low and high speed for No. 1 A/C	3-9		- - -
79.3	Request flight clearance, high speed for No. 2 A/C	3-9		7-30-64

<u>Number</u>	<u>Milestone</u>	<u>Revised Planned Date</u>	<u>Actual Date</u>	<u>Anticipated Date</u>
89	Start flight program on No. 1 A/C	3-13		- - -
78A	Government approval and flight clearance, of No. 1 A/C	3-16		- - -
79B	Government approval and flight clearance, high speed, No. 2 A/C	3-16		- - -
76.2	Complete pre-flight tests on No. 1 A/C	3-23		- - -
87	Demonstrate vertical take-off and transition to wing supported flight and from wing supported flight to fan support and vertical landing	4-17		- - -
71	Complete analysis of full scale wind tunnel data	4-30	7-31-64	

## VII. VISITS TO GOVERNMENT AGENCIES

<u>Date</u>	<u>Facility</u>	<u>Purpose</u>
*	Edwards Air Force Base	XV-5A Flight Test Coordination
*	NASA Ames	XV-5A Wind Tunnel Coordination

\* Since numerous visits were made to these agencies, the multiplicity of calendar dates has been omitted.



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